NITRATE AND NEBRASKA'S SMALL COMMUNITY AND RURAL DOMESTIC WATER SUPPLIES: AN ASSESSMENT OF PROBLEMS, NEEDS AND ALTERNATIVES

APPENDIX I

REPORT FOR:

TASK 2-1. ANALYZE SOCIO-ECONOMIC, ENVIRONMENTAL AND LEGAL/INSTITUTIONAL PROBLEMS, NEEDS AND CONDITIONS

NOTE: This task report was originally issued on August 4, 1998. It was later revised for inclusion as an appendix to the final report. Some material in this task report was originally compiled to provide information about a detailed study area that was to be examined according to an earlier study design. Although the detailed study area approach was subsequently dropped, that material remains in this report.

Nebraska Natural Resources Commission

August 4, 1998 / Revised June, 1999

Contents

List of Figures | Page

List of Tables .... Page

SUMMARY OF STATE LEVEL INFORMATION

Highights

Since 1981 fifty-nine Nebraska small cities, villages, and rural water systems have built or are in the process of constructing drinking water supply projects that are at least partially related to nitrate contamination. These projects have a combined cost of over $24 million. Overall, small (serving less than 10,000 people) city and village systems account for about 451 of Nebraska's 621 community water systems. The fifty-eight small city, village, and rural water systems that made drinking water infrastructure improvements related to nitrate contamination had a combined population of over 60,000 people which results in a per capita cost of about $404. Available records indicate that at least 168 of Nebraska's 451 small city and village water supply systems have had a nitrate sample over the 10 mg/l maximum contaminant level on at least one well, point of entry, or their system over that period. At least 296 small city and village water systems have had a reading over 5 mg/l.

During 1996 and 1997 combined nitrate contamination related drinking water projects of small cities and villages accounted for about 8.8% of total estimated final cost of Nebraska community water system infrastructure projects applications. In 1995 the U.S. Environmental Protection Agency estimated Nebraska's 20 year need for drinking water infrastructure at almost $953 million with small systems of under 3,000 accounting for $472.2 million of that need. It estimated Safe Drinking Water Act needs related to nitrate at only $8.4 million and total Safe Drinking Water Act needs at over $184 million. Given spending levels indicated in this report it appears the $8.4 million 20 year need ascribed to nitrate may be an underestimate.

In 1995 small city, village, and rural water system customers outside Omaha's Metropolitan Utilities District (MUD) account for just under 19% of Nebraska's population. MUD, Lincoln, and other communities of over 10,000 accounted for a combined 60% of Nebraska drinking water users. Self-supplied domestic users account for about 21% of Nebraska's population. A Nebraska Department of Health/UNL Conservation and Survey Division study which sampled 1,808 private domestic wells in 1994–95 found that approximately 19% of the wells were over the federal/state maximum contaminant level for nitrate-nitrogen.

The most common small city or village major infrastructure expenditure in response to encountering a nitrate problem is drilling a new well plus any transmission lines needed as a result. If there is no good source of supply in the immediate area, costs can rise as transmission lines need to become longer. In a few cases communities may go to the large expense of building a treatment plant.

Purpose

This task report is intended as draft input to the Bureau of Reclamation led Study "Nitrate and Nebraska's Small Community and Rural Domestic Water Supplies: An Assessment of Problems, Needs and Alternatives." The Natural Resources Commission serves as the state cost-share partner and state study team member in that effort. This summary provides an analysis of socio-economic, environmental, and legal/institutional problems, needs, and conditions relevant to the effect of nitrate-nitrogen on rural/small community water supplies in Nebraska. It provides information on: (1) economic costs of addressing nitrate related supply problems, (2) other socio-economic factors, (3) environmental factors that may affect supply and (4) the legal institutional framework. Although the full task report provides both statewide information and some information relevant to a six-county detailed study area, this summary provides only state level information.

Public Water Supply Systems

As of 1995 the primary source of domestic water for about 79% of Nebraska's population was from public water supply systems with self supplied domestic accounting for the remainder (Figure A) (NNRC, 1998). In 1995 domestic water use accounted for about 69% of total water use by public water systems. The remaining 31% was used for industrial, commercial, thermoelectric or other public water uses, or lost in transmission (NNRC, 1998). Groundwater supplied over 81% of publicly supplied water in Nebraska and virtually all self supplied domestic water. The Omaha area (Douglas and Washington counties) accounted for over 99% of publicly supplied water use from surface water. Therefore, groundwater is overwhelmingly the source for small community supply systems. Nebraska has about 1,340 public water supply systems (NHHS, 1997). A public water system is defined as one that has at least 15 service connections or that regularly serves at least 25 individuals.

There are three types of public water systems. Community water supply systems serve at least 15 service connections used by year round residents or regularly serve 25 year round residents. They include not only city or village systems, but such entities as rural water districts, sanitary improvement districts, or mobile home parks. In 1997 there were 621 community water supply systems of which 608 serve populations of fewer than 10,000 (NHHS 1997). As of 1995 there were 521 incorporated Nebraska communities with populations of under 10,000. Fifty-nine of those communities had no public drinking water system (Keefer and Lamberty 1995).

The other two types of public water systems are nontransient noncommunity water supply systems (185 systems) and transient noncommunity water supply systems (534 systems). A nontransient noncommunity water system is a system that doesn't qualify as a community water system but regularly serves at least 25 individuals over 6 months per year. Examples could

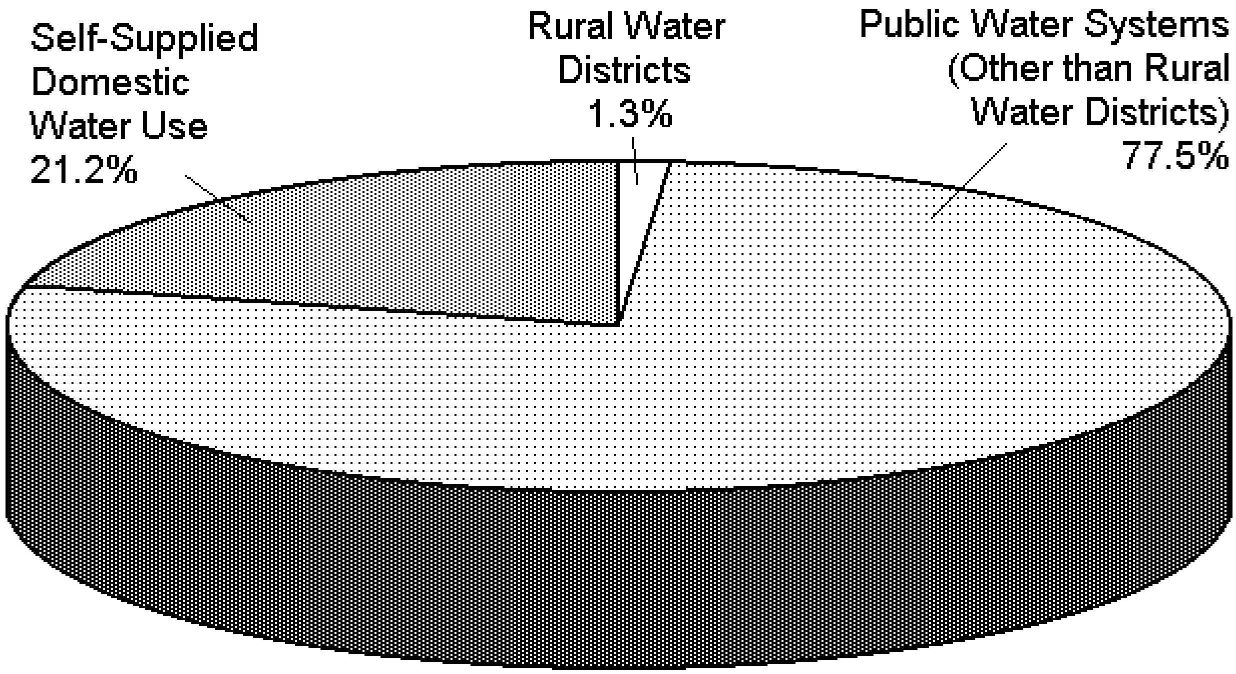


Figure A. Percentage of domestic water use by category, 1995.

include an industrial plant with its own well, or a rural school with over 25 students. A transient noncommunity water supply system is a public water system that does not regularly serve at least 25 of the same people over six months per year. Examples might include rest areas or a rural restaurant which has its own well.

The combined population of incorporated towns below 10,000 (outside the MUD area), rural water systems and self supplied population equals about 40% of Nebraska's population (Table A). However, those users in combination with community water systems not operated by incorporated cities or towns account for all but 13 of the 621 community water systems. Individual domestic wells supplied water for an estimated 110,754 households (Conservation & Survey Division and Nebraska Department of Health 1996).

Rural water systems are a special type of community water supply system that in 1995 served 22,581 Nebraskans or about 1.4% of the state's population. The 23 systems are found primarily in the eastern part of the state where availability of groundwater is less uniform. Service areas of the systems cover about 7% of the state's area and rural water systems delivered an estimated 917.68 million gallons of water in 1995 or about .88% of the state's publicly supplied water use (NNRC file estimates 1998). Figure B provides a map of system service areas. Since formation of the Natural Resources Districts (NRDs) in 1972, new rural water systems have come under the authority of the NRDs, but there is no requirement that previous districts be merged. NRDs currently operate eight public water supply systems serving over 3,095 customers and eight small communities. One additional water supply area is nearing completion.

Table A Community and Water Service Area Populations By Size Category – July 1, 1996 Estimates	
TOTAL STATE POPULATION – 1,648,696	
Metropolitan Utilities District Service Area Population	30.0%
Lincoln Population	12.7%
Population of Towns of Over 10,000 (Not Including MUD and Lincoln Areas)	17.5%
Rural Water Systems	1.4%
Self Supplied Population (Based on Use of 1995 Estimates of Self Supplied Population)	21.0%
*Other – Includes Population of Towns of Under 10,000 (but not including self-supplied towns, rural water systems, or areas served by MUD) plus Population of Small Community Water Systems (except rural water systems) not Affiliated with Systems of Incorporated Cities and Towns	17.4%
	100.0%

Sources: U.S. Bureau of the Census Figures – Released March 1998
Burns McDonnell, Inc. Platte River West Water Production Facilities Draft EIS 1998, prepared for Metropolitan Utilities District and U.S. Army Corps of Engineers Page 1-2 (for MUD Service Area Population Estimates)
Estimated Water Use in Nebraska; 1995 Nebraska Natural Resources Commission

NOTE: Rural water system and self supplied population figures use 1995 estimates.

* This figure was derived as a remainder after determining numbers for other categories. Actual estimated population of towns of under 10,000 in 1996 was 388,128 or 23.5% of the state's population.

Not all of Nebraska's small communities have public water supply systems. In 1995 Keefer and Lamberty (1995) analyzed drinking water sources and distribution systems for 521 Nebraska towns. As previously noted, they found that 59 towns had no public drinking water system. They also found that 282 of the communities had multiple wells but no common distribution system. Seventy-eight communities had single wells and only 55 communities had multiple wells on a common distribution system.

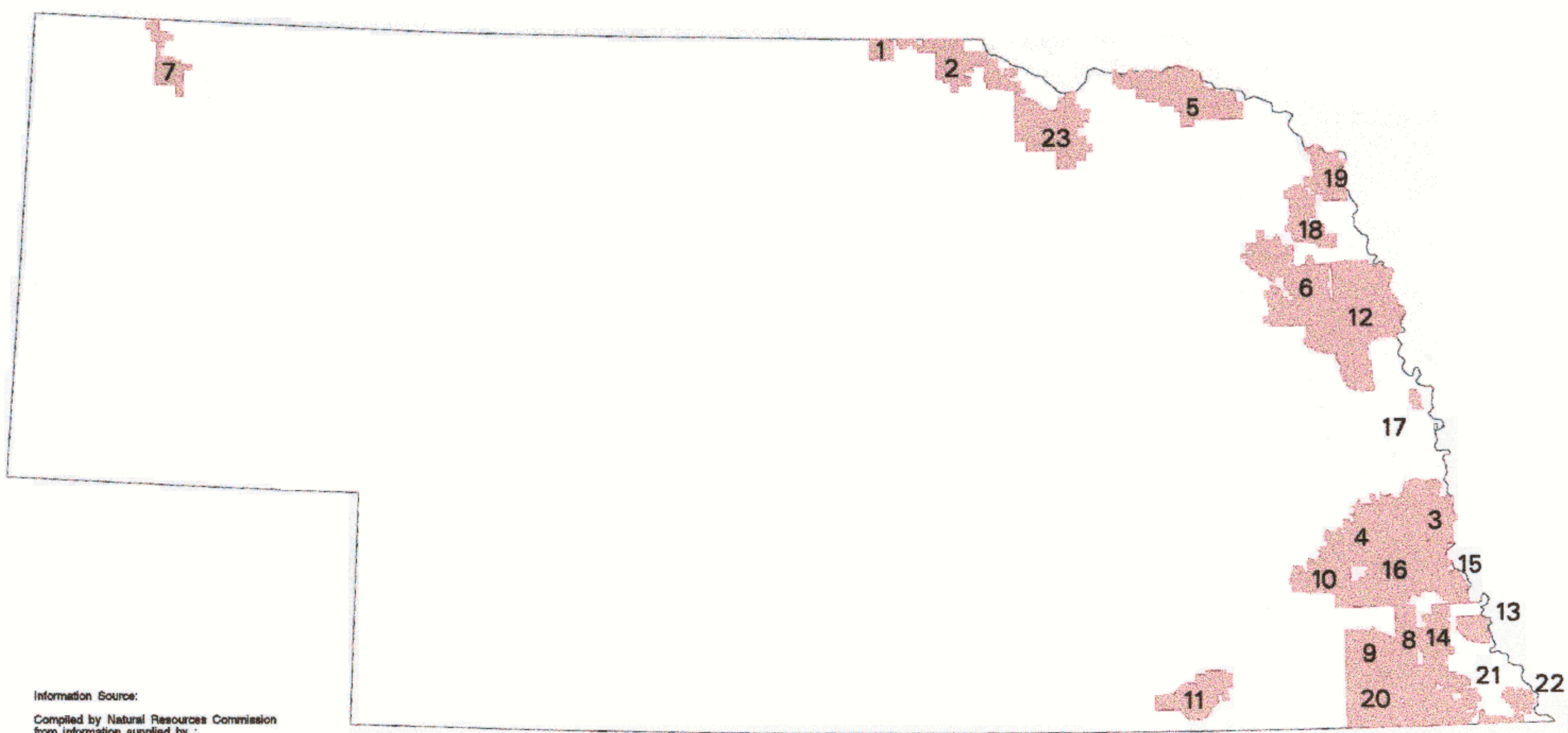
Public and Private Domestic Water System Siting and Construction

There are state requirements for monitoring and operation of public water supply wells. There are also requirements for siting, design and construction of new public water wells.

Figure B
Nebraska Rural Water Systems — November 1995

SCALE 1:3,000,000

1. Boyd County RWD1
2. Boyd County RWD2
3. Cass County RWD1
4. Cass County RWD2
5. Cedar-Knox RWD
6. Cuming County RWD1
7. Dawes County RWD1
8. Johnson County RWD1 East
9. Johnson County RWD1 West
10. Lancaster County RWD1
11. Little Blue NRD RWD1
12. Logan East RWD
13. Nemaha County RWD1
14. Nemaha County RWD2
15. Otoe County RWD1
16. Otoe County RWD3
17. Papio-Missouri River NRD RWD1
18. Papio-Missouri River NRD RWD2
19. Papio-Missouri River NRD RWD3
20. Pawnee County RWD1
21. Richardson County RWD1
22. Richardson County RWD2
23. West Knox RWD



Information Source:

Compiled by Natural Resources Commission
from information supplied by :
USDA Rural Development
Nebraska Rural Water Association
Selected Natural Resources Districts
Selected Rural Water Districts
Produced By - Natural Resources Commission
GIS Process - ARC/INFO
Processed - April 1998

However, construction, hydrologic or site factors are nonetheless often significant factors in nitrate problems. The most common major small community public water system infrastructure expenditure in response to encountering a nitrate problem has been drilling a new well plus any transmission lines needed as a result. If there is no source of water with usable quantity and good quality in the immediate area, costs can rise as transmission lines need to become longer. In a few cases a community may even find it cost effective to go to the large expense of building a treatment plant.

A poorly sited or constructed (or shallow) well may be more susceptible to smaller point sources of contamination that don't affect a large area. Private domestic wells with older construction are more likely to be affected by construction and siting problems. Large diameter private wells in eastern Nebraska are especially subject to problems. In many instances increased well depth or grouting could solve the problem. Private domestic wells that do have nitrate problems should also be checked for pesticides.

Trying to pin casual factors between well siting and nitrate sources for either public systems or private domestic wells is a difficult and perhaps subjective matter. Theoretically, a truly poorly sited well might be a shallow well at the only contaminated level of the only contaminated part of a large aquifer. On the other hand in very contaminated areas or areas with a limited aquifer it may theoretically be impossible to find an area of uncontaminated aquifer for a some distance. In between those two extremes are a large array of potential relations between well site and nitrate sources. In instances where nitrate sources have increased, older, poorly sited wells might be most likely to be affected or be affected first. This task report did not examine the age, depth, or construction of the public water supply wells that had high nitrate readings and were replaced or relegated to backup status.

The report entitled *Domestic Well-Water Quality in Nebraska* (UNL Conservation and Survey Division and Nebraska Department of Health 1996) identified a number of factors which could influence occurrence of contaminants in private domestic wells. Those factors generally are also applicable to public water wells and are worth repeating here. They include: "well construction factors, which include: casing type, installation date (age), diameter, well completed in or out of pit, sanitary seal, and well type; distance factors, which include distance to cesspool, septic systems, waste lagoons, barnyards, pasture, and cropland; and hydrologic and site factors, which include: well depth, depth to water, landscape and soil characteristics, and nearby chemical use."

Economic Costs of Addressing Nitrate Related Supply Problems

Data compiled for this report indicates that since 1981 fifty-eight small Nebraska cities, villages and or rural water systems have built or are in the process of constructing nitrate contamination related drinking water projects with a total estimated final cost of over $24 million. In some ways this figure is overstated, because nitrate was only one of the reasons some of the projects were built. It should be noted that monitoring as well as operation and maintenance of treatment facilities are not included in this figure. If the total amount is adjusted into 1997 dollars it becomes $28 million. The 58 small cities, villages and rural water systems had a combined population of 60,091 and on that basis paid an average of about $410 per capita for the improvements. Projects submitted for Nebraska Health and Human Service System review and approval in 1996 or later account for much of that total.

In comparison to overall water system expenditures or an EPA survey of water system infrastructure needs, this number is small. Figures compiled for this report indicate that in 1996 and 1997 combined small city, village and rural water system nitrate contamination related water system projects accounted for only 8.8% of total small community water project (including water main) construction approved by the Nebraska Health and Human Services System. Of the 55 public water supply wells approved for construction during that period, 16 were for projects related to nitrate contamination. In 1995 the U.S. Environmental Protection Agency estimated Nebraska's total 20 year need for water system infrastructure at almost $953 million. At $472.2 million, small systems (serving fewer than 3,300 in the EPA study) accounted for nearly half of the 20 year Nebraska infrastructure need. EPA estimated 20 year total Nebraska Safe Drinking Water Act needs related to nitrate at only $8.4 million and total Safe Drinking Water Act related needs at over $184 million.

When a public water supply system is significantly out of compliance with standards Nebraska Health and Human Services System issues an administrative order. Failure to comply with the terms of the administrative order can result in action to revoke the system's permit to operate. While the administrative order is in effect and the community is in the process of addressing the problem, no other enforcement for violating that particular maximum contaminant level will be initiated.

Nitrate accounted for nearly half of water quality violation administrative orders in the 1991 to 1997 time period with a total of 34 of the total 69 administrative orders issued. Changes in EPA standards related to a range of contaminants/problems may result in nitrate accounting for a relatively smaller portion of administrative orders, even if the actual number of nitrate related administrative orders remains the same. Requirements related to lead, copper, arsenic, radon and potentially in the future mandatory disinfection may result in the need for additional system improvements in some small communities.

Sixty-four Nebraska community water systems were under administrative order from the Nebraska Health and Human Services System to bring copper levels under an EPA required level of 1.3 milligrams per liter as of mid-1998. This extreme increase in the number of administrative orders is a result of EPA's adoption of new requirements; not of systems rising above previous requirements. Although the 1995 EPA infrastructure needs inventory estimated the 20-year cost of compliance with the lead and copper rule at only $4.3 million there is reason to believe that may be a very substantial underestimate. For instance, it has been estimated that the rule will cost the City of Hastings alone $1 million in treatment equipment initially plus $250,000 per year in operating costs. With 64 communities under administrative order, it seems likely that this new requirement and other potential requirements such as mandatory disinfection could result in very substantially increased infrastructure costs for Nebraska small communities.

Table B provides a summary of small community water system data and related project costs. Table C provides a list of those communities and their approximate costs. Figure C identifies small cities or villages which had nitrate related drinking water system infrastructure projects between 1981 and 1997. Figure D provide a rough estimate of costs for nitrate related projects by year since 1982.

Significant maintenance costs for communities which built water treatment systems in response to nitrate problems would push overall cost figures higher. There are also increased monitoring costs for communities which are required to sample on a quarterly basis as a result of elevated nitrate levels. Communities which exceed a 5 mg/l monitoring trigger at their point of entry must sample on a quarterly basis until readings have been under 8 mg/l for four consecutive quarters. As of January 1998 it cost $18.10 to have a sample analyzed for nitrate-nitrogen by the Nebraska Department of Health and Human Services.

The most significant single cost impact from nitrates may come if they result in a community needing to treat its water. In 1995 Keefer and Lamberty (August 1995) noted that as of that time "only 44 of the 425 towns with wells treat their drinking water; 28 disinfect, 5 treat for nitrates, and 21 remove iron and manganese." Most of those towns had multiple wells but no common distribution system. The costs of going to treatment, whether for nitrate or other causes can be very high for such communities, much higher than the cost of drilling a new well.

Available data seem to indicate that since 1981 seven Nebraska small cities or villages have built or undertaken nitrate contamination related drinking water projects that have included new water treatment plant facilities. The cost of that infrastructure was about $6,933,512. These seven small cities or villages constitute about 12 % of all nitrate contamination related infrastructure improvement over that period, but about 28% of the costs. Treatment facilities also generally have very significant operation and maintenance costs.

Nitrates are likely to continue to be a significant issue to communities. The Nebraska Mandates Management Initiative provides a specific case in point. That program is administered by the Department of Environmental Quality and has delivered direct technical assistance on infrastructure problems to a range of communities. Of the 83 communities that had full participation in the program between May 1995 and January 1998, 42 had nitrate concerns listed as an identified issue. Sixteen of the eighty-three communities had received an administrative order for nitrate at some point since 1981 (NDEQ 1998).

Although the above infrastructure costs are very significant, they were not all paid by the water systems or consumers. Community Development Block Grants and grants and loans from the U.S. Department of Agriculture accounted for much of that cost. An analysis of water rates for most of the affected communities revealed communities which had addressed infrastructure problems due to nitrate had only marginally higher rates versus other communities.

**Table B. — Small City and Village Water System Project Costs —
Projects for Which Nitrate Was One of the Major Reasons for Initiating the Project
(Current as of May 1998; (Community Systems Serving Under 10,000 People Only)**

# of Community Water Systems Serving Under 10,000 People (1997) – 608

# of Community Water Systems That are Small City or Village Systems – 451

# of Small City and Village Community Water Systems Where a Point of Entry or the System Has Had One or More Samples Above 5 ppm Nitrate-Nitrogen Since 1981 – 296* (through 1998)

# of Small City and Village Community Water Systems Where a Point of Entry or the System Have Had One or More Samples Above 10 ppm since 1981 – 168* (through 1998)

% of Water Quality Violation Administrative Orders Related to Nitrate 1991-1997 - 49% (34 of 69)

# of Nitrate Related Administrative Orders Issued 1981 to March 1998 – 74

# of Small Community Water Systems Receiving Nitrate Related Administrative Orders – 1981 to March 1998 – 62

# of Small Cities, Villages and Rural Water Systems Receiving Nitrate Related Administrative Orders (1981-1997) Which Later Made Nitrate Related Infrastructure Improvements – 36 (also another 5 community water systems not related to incorporated cities and villages, or rural water systems)

# of Community Systems That Received Nitrate Related Administrative Orders 1981–1997 Where No Record Found of Major Nitrate Related Infrastructure Improvement (Note: Only 9 of these were incorporated city or village operated systems) – 21

# of Small City, Village or Rural Water Systems That had no Administrative Orders but made Substantial Infrastructure Improvements That Appear to be Related to Nitrate – 23

Approximate Nitrate Related Infrastructure Project Expenditures for Small City, Village or Rural Water Systems Receiving a Nitrate Related Administrative Order Since 1981 (Including Estimates for Projects Underway) – $11,283,298 (includes total costs of projects for which nitrate was one of the major reasons or the major reason for initiating the project)

Rough Related Infrastructure Project Expenditure Estimate for All Small City, Village or Rural Water Systems Making Nitrate Related Infrastructure Project Expenditures Since 1981 (Including Estimates for Projects Underway) (includes total costs of projects for which nitrate was one of the major reasons or the major reason for initiating the project)) – $24,667,600

Total 1998 Population of Small Cities and Villages Which Have Made Nitrate Related Infrastructure Project Expenditures Since 1981 or Currently Have Such Projects Underway – 60,091

Estimated Final Per Capita Costs of Nitrate Related Infrastructure Improvement Projects Completed or Underway for Small Cities and Villages Making Improvements Since 1981 – $410

Inflation Adjusted Total Cost of Nitrate Related Infrastructure Improvement Projects 1981 Through 1998 in 1998 Dollars (including estimates for projects underway) Includes Total Costs of All Projects for Which Nitrate Was a Major Reason or the major Reason for Initiating the Project – $28.1 million

Nitrate Related Projects Accounted for This % of Overall Estimated Cost of Water Projects Approved in 1996 and 1997 – 8.8%

*It is not known how complete available records are. Therefore, it is possible that readings above these respective levels may have been experienced by additional community systems.

TABLE C

Estimated Cost of Nitrate Related Infrastructure Completed or Underway by Small Cities, Village and Rural Water Systems 1981 – early 1998

[Compiled from a survey conducted for this study and from the records of the Nebraska Health and Human Services System and the Community Development Block Grant Program. Includes projects submitted for HHSS review in 1997 or early 1998 but for which actual construction may not have begun. Surveys were sent to 87 small city or village water systems which (1) had a nitrate sample over 5 mg/L since 1981 or had a nitrate related administrative order, and (2) were identified as having undertaken a subsequent water-supply project that may have been related to nitrate. Responses came back from 79 small cities or villages. A final list was developed that included 59 communities identified as having made nitrate-related water-system expenditures. That list includes five villages that were unconfirmed (four of which made improvements subsequent to receiving an administrative order). It also includes one village that did not receive a survey but was installing its first water system. Three villages that had received no administrative order and did not respond were excluded from the final list. The listed sources of cost data do not denote funding sources. While figures used are not exact, in the composite they provide a rough estimate of total project costs.]

Record of Administrative Order	HHSS Review Year[1]	Completion Year	Name of System	Population (1996)	Cost	Source of Cost Data[2]	Cost per Capita	ENR Index[3] Start year +1	Cost In 1997 Dollars
AO	1989	1991	Adams[4]	476	$ 399,000	CDGB/TOWN	$ 838.24	4732	$ 491,246
AO	1987	1989	Bartley	333	$ 106,072	TOWN	$ 318.53	4519	$ 136,750
AO	1996		Bazile Mills	35	$ 118,500	HHSS/TOWN	$ 3,385.71	5826	$ 118,500
AO	1987		Belden	146	$ 105,000	HHSS/TOWN	$ 719.18	4519	$ 135,368
	1996		Benkleman[5]	1071	$ 705,491	TOWN	$ 658.72	5826	$ 705,491
AO	1988	1992	Bradshaw[6] (unconfirmed)	343	$ 381,600	CDGB	$ 1,112.54	4615	$ 481,734
AO		1982	Bruning	324	$ 200,000	TOWN	$ 617.28	3535	$ 329,618
AO		1998	Brunswick	170	$ 503,900	CDGB/TOWN	$ 2,964.12	5826	$ 503,900
AO	1985	1988	Burwell	1250	$ 240,000	TOWN	$ 192.00	4295	$ 325,551
	1997		Central City	2906	$ 107,000	HHSS/TOWN	$ 36.82	5826	$ 107,000
	1997		Chapman[7]	296	$ 1,245,600	CDGB	$ 4,208.11	5826	$ 1,245,600
AO	1989	1993	Creighton[4,8]	1149	$ 1,035,000	CDGB/TOWN	$ 900.78	4732	$ 1,274,284
AO		1984	Danbury	107	$ 176,000	CDGB/TOWN	$ 1,644.86	4066	$ 252,183
	1997		Deshler	833	$ 200,000	TOWN	$ 240.10	5826	$ 200,000
	1990		Diller[9]	297	$ 260,000	TOWN	$ 875.42	4835	$ 313,291
AO	1985	1988	Dodge	686	$ 92,083	TOWN	$ 134.23	4295	$ 124,907
AO	1984		Duncan[6] (unconfirmed)	372	$ 148,500	CDGB	$ 399.19	4195	$ 206,236
AO	1989	1992	Edgar[6] (unconfirmed)	636	$ 168,800	CDGB	$ 265.41	4732	$ 207,825
AO	1990		Elmwood[4]	611	$ 486,948	CDGB/TOWN	$ 796.97	4835	$ 586,755
AO	1990	1992	Funk	202	$ 422,300	CDGB/TOWN	$ 2,090.59	4835	$ 508,856
	1986		Genoa	1069	$ 499,500	CDGB/TOWN	$ 467.26	4406	$ 660,483
AO	1996		Gibbon	1473	$ 875,605	TOWN	$ 594.44	5826	$ 875,605
AO	1986	1989	Goehner	192	$ 159,500	CDGB/TOWN	$ 830.73	4406	$ 210,905
AO	1989	1992	Hampton	418	$ 409,400	CDGB/TOWN	$ 979.43	4732	$ 504,050

	1992		Hardy[4]	199	$ 396,200	CDGB/TOWN	$ 1,990.95	5210	$ 443,044
AO	1986	1988	Hickman	1150	$ 297,700	CDGB/TOWN	$ 258.87	4406	$ 393,645
AO	1986		Hildreth[6] (unconfirmed)	361	$ 92,000		$ 254.85	4406	$ 121,650
	1997		Hordville[10]	168	$ 245,000	HHSS/TOWN	$ 1,458.33	5826	$ 245,000
	1987	1992	Howells[11]	687	$ 665,000	CDBG	$ 967.98	4519	$ 857,333
AO	1985	1989	Indianola	630	$ 309,896	TOWN	$ 491.90	4295	$ 420,362
AO	1985	1988	Johnson	333	$ 205,312	TOWN	$ 616.55	4295	$ 278,498
AO		1985	Lebanon	72	$ 222,000	CDGB/TOWN	$ 3,083.33	3825	$ 338,136
AO	1985		Liberty	75	$ 52,650	HHSS/TOWN	$ 702.00	4295	$ 71,418
AO	1986	1988	Martinsburg	93	$ 32,000	CDGB/TOWN	$ 344.09	4406	$ 42,313
AO	1988	1995	McCook	7926	$ 780,000	CDGB/TOWN	$ 98.41	4615	$ 984,676
	1992		Mead	535	$ 70,000	HHSS/TOWN	$ 130.84	5210	$ 78,276
AO	1986	1988	Milford	1989	$ 235,800		$ 122.62	4406	$ 322,485
	1990	1992	Obert	38	$ 40,000	TOWN	$ 1,052.63	4835	$ 48,199
	1996		Otoe CoRWD	2294	$ 255,290	HHSS/TOWN	$ 111.29	5826	$ 255,290
	1992		Overton[12]	766	$ 422,800	HHSS	$ 551.96	5210	$ 472,789
AO	1992	1994	Page[4]	182	$ 380,000	TOWN	$ 2,087.91	5210	$ 424,929
AO		1998	Paxton	523	$ 1,164,000	TOWN	$ 2,225.62	5826	$ 1,164,000
AO	1991		Pickrell[6] (unconfirmed)	205	$ 72,440	HHHS	$ 353.37	4985	$ 84,661
	1993		Pleasant Dale	250	$ 116,000	CDGB	$ 464.00	5408	$ 124,966
	1993		Rockville[13]	115	$ 356,586	HHSS	$ 3,100.75	5408	$ 384,148
AO	1993		Royal	75	$ 50,000	CDGB	$ 666.67	5408	$ 53,865
	1996		*(Seward[14])* *see final note*	*(6093)*	*($ 1,928,000)*	*(HHSS/TOWN)*	*($ 316.43)*	*(5826)*	*($ 1,928,000)*
	1992		Sidney	6128	$ 1,500,000	HHSS/TOWN	$ 244.78	5210	$ 1,677,351
AO	1985		Sprague	150	$ 85,000	TOWN	$ 566.67	4295	$ 115,299
	1997		Springview[15]	297	$ 435,328	TOWN	$ 1,465.75	5826	$ 435,328
	1995		St. Paul[4]	2181	$ 3,250,874	TOWN	$ 1,490.54	5620	$ 3,370,034
	1989		Sterling	449	$ 69,800		$ 155.46	4732	$ 85,937
AO	1986		Utica	752	$ 115,708	CDGB/TOWN	$ 153.87	4406	$ 152,999
AO	1989		Wilcox	359	$ 297,000	CDGB/TOWN	$ 827.30	4732	$ 365,664
AO	1988		Wilsonville	140	$ 378,600	CDGB/TOWN	$ 2,704.29	4615	$ 477,947
	1983		Winnetoon	60	$ 95,700	CDGB/TOWN	$ 1,595.00	4146	$ 134,479
	1996		Wisner	133	$ 154,133	TOWN	$ 1,158.89	5826	$ 154,133
AO	1985	1987	Wood River	1257	$ 562,900	CDGB	$ 447.81	4295	$ 763,552
	1996		York	8146	$ 280,000	HHSS/TOWN	$ 34.37	5826	$ 280,000
			TOTAL	60,091	$ 24,667,600		$ 409.72		$ 28,056,574

Footnotes for Table C.

[1] Some projects had more than one review year. In those cases the latest one is given.
[2] CDGB, Community Development Block Grant files. HHSS, Nebraska Health and Human Services System files.
[3] Engineering News Record cost index for the year following the project's starting year.
[4] Built a treatment facility.
[5] Survey response noted "nitrate was one of the reasons – however, the quantity of water that could be pumped from existing wells was probably a more important factor."
[6] Not confirmed, but town did receive an administrative order for nitrates and made improvements shortly thereafter.
[7] Town had no community water system. Installation is occurring in part due to nitrate in individual wells. No survey was sent to this town.
[8] Creighton survey response specifically noted that nitrate was the only reason for the treatment plant.
[9] Telephone follow-up survey of Diller indicated that nitrate was a contributing factor, as well as manganese and pumping clay.
[10] Hordville expenses were first for carbon tetrachloride problem, but then nitrate problem also from survey response indicated total cost would likely be for considerably over $245,000, but overall figure not available.
[11] Howells project not yet complete and town survey response noted final cost was expected to be $780,000 to $850,000.
[12] Overton indicated well replacement around 1982 as well, also due to nitrate. Also storage was improved at that time.
[13] Town not contacted. However, town installed water system due to nitrate in individual wells.
[14] *Seward survey response also noted "projected water treatment at $4,500,000." Only $1,928,000 project submittal to HHSS in 1996 was used in this table. However, as of June 1999 action on a treatment system was postponed. It is therefore arguable that this entry should not be included in this table. However, it has been included in table and summary statistics.*
[15] Nitrate only one factor. Town put in extensive mains, hydrants and other infrastructure as well.

In addition to the small city, village and rural water systems included in this table, some evidence was found that at least an additional 5 community water systems that received administrative orders and were not operated by cities or villages made improvements with a cost of $176,542 over the period. Those amounts are not included in the totals in this table.

No Survey Response – Not Included

It is not known whether the following communities made infrastructure improvements in response to nitrate. They are therefore not included in the summary statistics. All of these communities had a nitrate reading above 7 ppm and later made system improvements after which nitrate levels dropped. However, none of the communities received administrative orders. In the survey of communities with similar characteristics a majority of the changes were not nitrate related. No survey response was received from these towns.

Community	Year of Project Initiation	Cost
Cody	1983	$375,850
Elk Creek	1997	$27,507
Fullerton	1994	$18,000

Unsurveyed Nonmunicipal Systems

West Park Plaza	$20,000
Mobile Manor	$18,000
Green Acres Mobile	$5,600

Sources: Nebraska Health and Human Services System – Public Water System Files (HHSS)

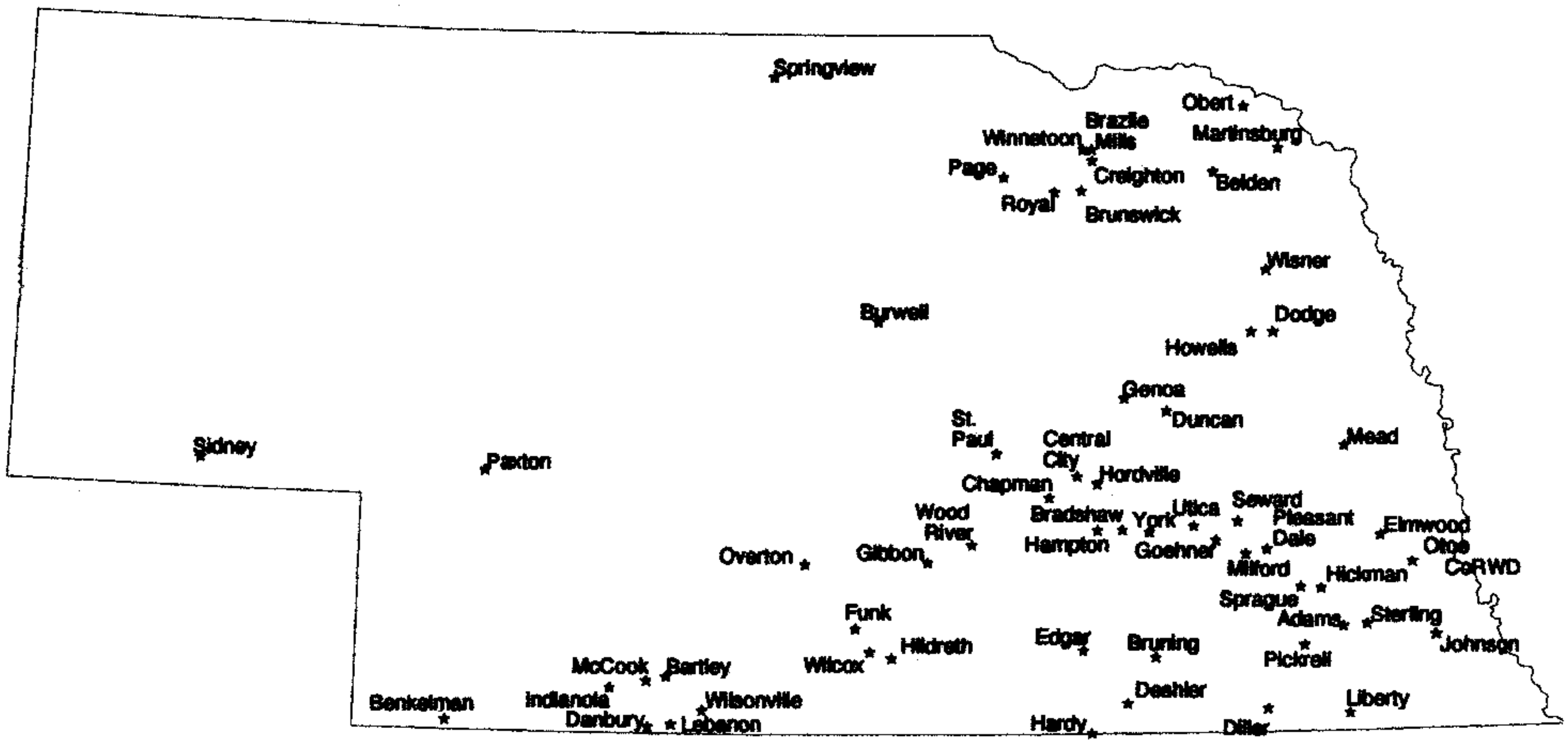
Nebraska Department of Economic Development – Community Development Block Grant Files (CDBG)

Natural Resources Commission Survey of 92 Selected Small City and Village Water Systems

Table Compiled by Nebraska Natural Resources Commission

Figure C
SMALL CITIES OR VILLAGES OF 10,000 OR LESS
Which had Major Nitrate Related Community Drinking Water System Infrastructure Projects Completed or Underway 1981 - 1997

(Includes projects approved in 1997 but for which construction may not begin until later)



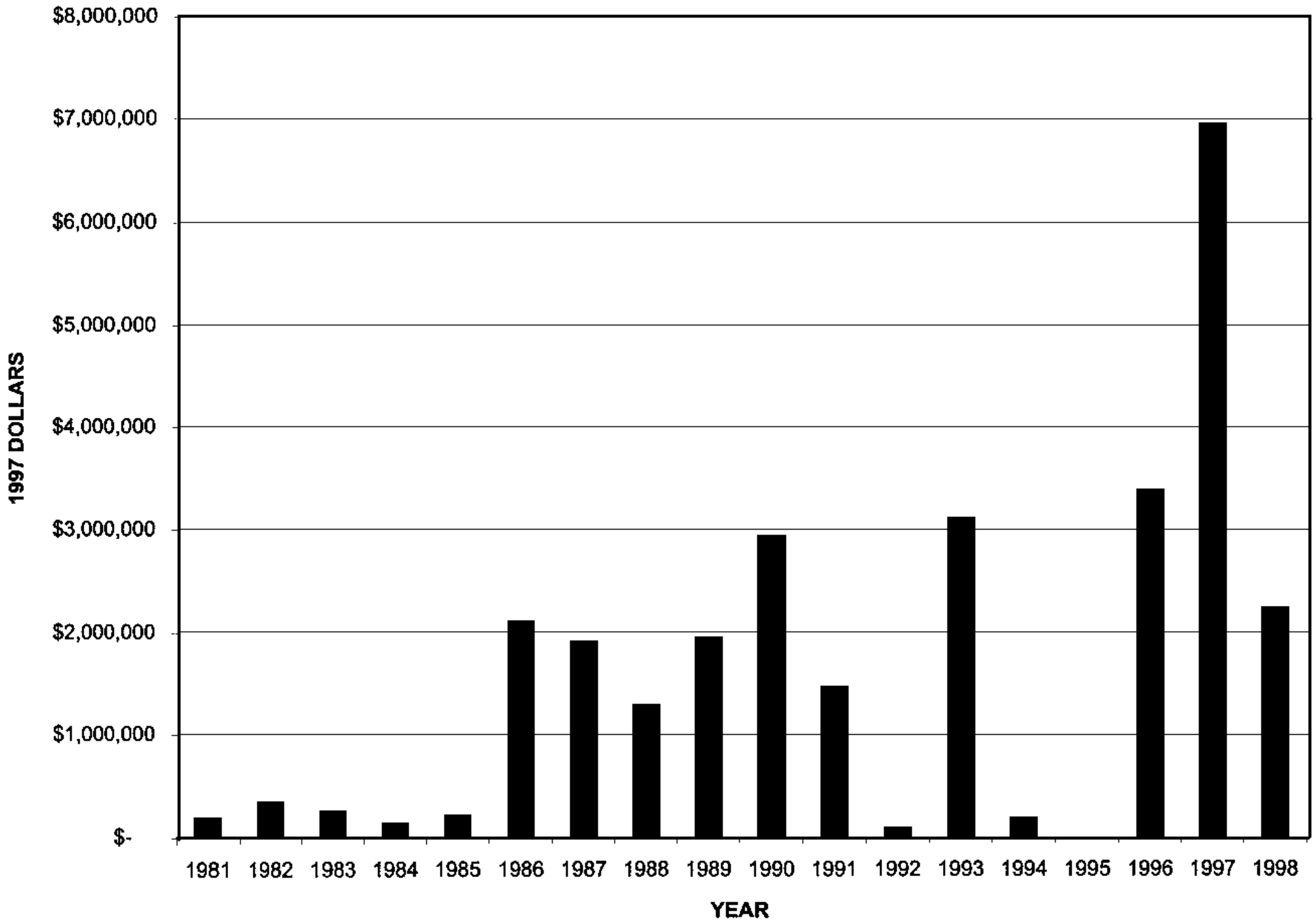
Information Sources:

Nebraska Health and Human Services System
Public Water System Files
Nebraska Department of Economic Development
Community Development Block Grant Files
Survey of 92 Nebraska Communities by Nebraska
Natural Resources Commission
Produced By - Natural Resources Commission
Cities - TIGER Files
GIS Process - ARC/INFO
Processed - August 1998

*Communities included, with a few exceptions, either responded to a survey or had received an administrative order and subsequently under took improvements. In some instance communities may have simultaneously undertaken other drinking water infrastructure improvements or improved a system more than was needed to address the nitrate problem. Insufficient information was available to exclude those types of expenditures from this table. Community water systems other than cities or villages are not included on this map.

Figure D

Rough Adjusted Annual Cost of Nitrate Related Projects by Small City, Village and Rural Water Systems. 1982-1998 includes projects reviewed by NHHS but not yet built.*



***Assumes all project costs come in the year after project review by NHHS or in few cases in year prior to project completion.**

Economic and Social Costs to Self Supplied Domestic Users

Public water supply systems are not the only consumers affected by the costs of responding to nitrate related contamination. A Nebraska Department of Health study which sampled 1,808 private domestic wells in 1994–95 found that approximately 19% of the wells sampled were over the federal maximum contaminant level for nitrate nitrogen (CSD/NDOH April 1996). In 1990 an estimated 110,754 households were supplied by individual domestic water wells (1980 and CSD/NDOH, April 1996). NNRC estimates indicate about 21% of Nebraskans were served by self supplied domestic water in 1995. Because the wells selected for the CSD/NDOH study were from residences where occupants were actively engaged in farming and/or occupied at least 6 acres of land, the samples may well not accurately reflect all private wells. It seems possible that wells on smaller nonagricultural plots might either tend to be of more recent vintage or tend to have been subject to a change of ownership that resulted in well improvements. However, they may also be more concentrated and possibly more subject to septic tank contamination. Private well use is expanding in the rural areas around Lincoln, Omaha and Grand Island.

Whatever conclusions are drawn about the level of health risk the CSD-NDOH study's monitoring results may pose, it does indicate the potential for nitrate related expenditures by owners of some private domestic wells. If costs of deepening or replacing private domestic wells may be in the $1,500 to $5,000 dollar per well range (including pump and pipe), the costs of bringing all wells into compliance could be very high even if those wells could be identified. However, the availability of other options such as point of use treatment and concerns about the cost effectiveness given the level of health risk to individuals other than pregnant women and infants are among factors that are likely to be relevant to any response. Increased well depth and grouting are a likely solution to many domestic well problems. Alternatives for self supplied rural domestic water users are discussed elsewhere in this report. No survey was done of how many rural domestic well owners with high nitrates are using point of use treatment.

The percent of rural domestic water users who test their water and have an idea of nitrate levels is not known. Data from a nine state 1994 survey of 5,520 private well users by the Centers for Disease Control (CDC 1996) show that 44% of those responding said their wells had never been tested for contamination, 44% said it had and 11 percent did not know. That study included Nebraska. However, nitrate is among the easier and more common contaminants to test for and Nebraskans awareness of those problems may make testing more common in the state.

As of 1995 there were 59 Nebraska towns which had no public water systems. In addition there are unincorporated developments without public water supplies. The proximity of septic tanks and wells in a concentrated space is of concern in some of these areas (although there are also towns that have no public water supply system but do have wastewater treatment facilities). In many cases the older domestic wells may not be as well sited or constructed as a community well would be. At least one small town was installing its first community water system as this report was being written. Some areas with concentrations of residences without a public water supply are potential candidates for adoption of community water systems.

Other Socio-Economic Factors

Demographic factors can affect rural/small community water supply issues through impacts on water quality, the need for additional water supply infrastructure and the ability to pay for new or existing infrastructure. Nebraska's population has increased by nearly a quarter since 1950, rising by an estimated 326,583 people between the 1950 census and July 1996 population estimates. However, that growth was not distributed evenly. The Omaha and Lincoln metropolitan areas alone grew by 375,121 people over that period. The Bureau of Business research projects the state's population to increase 13.4% between 1990 and 2000. Fifty-seven of the state's 93 counties are expected to have increases in working age population.

The economic well being and capacity of communities to pay are significant factors in water infrastructure decisions. The Nebraska Mandates Management Initiative has developed an evaluation for small community ability to pay based upon median household income, per capita income and valuation per capita. Supalla and Ahmad (1997) developed a financial capacity index based upon average household valuation and the percent of households in ten different income classes. Their estimates of financial capacity for 440 Nebraska communities with populations of 5,000 or less ranged from 9 dollars to 110 dollars per month. That type of range indicates major variations in community capacity. Even after examining those indexes other factors must be accounted for, including: financial obligations, expected population changes, income source types (fixed or variable) or other public works problems.

Social factors that must be taken into account in dealing with elevated levels of nitrate in drinking water can include fear, inconvenience, and health risks.

Current and Future Small Community and Rural Domestic Water Demand

Future small community and rural domestic water demand will depend upon population change, water rates, climatic conditions and conservation practices. Bureau of Census figures indicate that of 330 Nebraska communities of under 500 population in 1990, about 63% (207) had declined in population since 1970. The median community of under 500 experienced a 7% population decrease. Of the 205 communities of over 500 people 52% (106) declined in population over the same period. Of 535 total Nebraska communities, 313 declined in population over the 20 year period. Plots of total domestic, public supplied domestic and private supplied domestic water indicate that rates of water use across Nebraska increase from east to west as precipitation decreases from east to west. Declining population could affect ability to pay in some communities forced to make water infrastructure improvements.

While population is the initial factor to examine when determining small community and/or rural domestic water demand, a number of factors can affect per capita demand. These include: changes in household size, changes in conservation measures, changes in industrial-commercial use, changes in system efficiency and changes in cost of water to the consumer.

Factors That May Affect Supply

Land Use/Human Activities

Land use related factors potentially relevant to rural/small community water supply in Nebraska include: changes in cropping patterns, changes in the amount of irrigated land, other land use changes, fertilizer use, irrigation well registrations, water use data, livestock numbers, changing use of agricultural best management practices, waste disposal practices, and population levels.

The amount of irrigated land on farms in Nebraska rose 190% between 1964 and 1992 and in 1992 comprised 12.9% of the total land in the state according to U.S. Bureau of the Census data. This was up from 4.1% of land in 1959. Corn accounted for almost 45% of harvested acreage, up from just over 37% in 1959. Soybean acreage grew from less than 1% of harvested acreage in 1959 to more than 14% in 1992 according to Census of Agriculture data. Harvested cropland in 1992 comprised just under 1/3 of the state's total land. Between 1962 and 1994 the tonnage of commercial fertilizer sold in Nebraska rose 491%. Between 1950 and 1996 the inventory of hogs and pigs on farms in the state rose over 64% and the number of cattle on farms rose over 65%. However, cattle and calf inventories were almost the same in 1996 as they were in 1970 and hog and pig inventories in 1996 are lower than they were in 1980.

Cumulative registered irrigation well numbers in Nebraska rose from 4,068 in 1956 to 29,167 in 1966 to 84,501 in 1996. In 1995 irrigation accounted for over 93% of Nebraska groundwater use.

Unpublished working estimates by some staff at the Department of Environmental Quality indicate there are probably around 250,000 septic tanks in the state and around 8,000 to 10,000 are being added each year (Goans 1998). The 1990 Census of Housing indicated 117,460 septic tanks. Landfills are an additional potential source of contamination. In the 1990s Nebraska updated its solid waste management policies and substantially reduced the number of landfills in the state.

Standing alone, data on increased irrigation, increased fertilizer use, and increases in human and some livestock numbers would seem to indicate the potential for some increase in potential threats to the water supply. However, those data must be balanced against increased use of agricultural best management practices, better waste management practices and better well construction techniques. Irrigation water management/fertilizer use practices are being addressed in the groundwater management areas of most of Nebraska's natural resources districts and by a wide array of educational programs. The Bureau of Reclamation is completing a separate report to analyze the effect of best management practices and any trends.

Environmental Setting

Among the environmental setting factors most relevant to rural/small community water supplies are probably occurrence of groundwater, depth to water, and geologic factors. The U.S. Bureau of Reclamation is compiling those items in a separate work element report. Other relevant factors include topography, climate, soils, vulnerability to contamination, natural vegetation, and occasionally fish and wildlife.

Topography can constrain the degree to which land is utilized for irrigation or cropping. Land with higher slopes can also have less pollution potential due to higher runoff and erosion rates, which include the pollutants that infiltrate the soil. A map of Nebraska topographic features is included as part of this report.

Climatic factors can affect rural/small community water demand, which crops are grown in an area and the potential for leaching or runoff of nutrients and pesticides.

Soil conditions can influence small community and rural water supplies by affecting the infiltration rate of contaminants from the surface. Permeability is the quality that enables water to move downward through the soil profile. This report presents maps on soil permeability. It also presents a generalized map of groundwater contamination to vulnerability based on the DRASTIC method. DRASTIC is an acronym for the factors used: depth to water, **r**echarge, **a**quifer media, **s**oil media, **t**opography, **i**mpact of the vadose zone, and **c**onductivity (hydraulic).

Vulnerabilities tend to be higher in river valleys, the Sandhills and Sandhills fringe, portions of the Panhandle, the Upper Republican, Upper Elkhorn, and Upper Blue Basins. Ideally the DRASTIC map would be compared with a land use map (Figure 9) and an irrigation wells map (Figure 14). Areas with cropping, irrigated cropping and urban uses generally have more potential for placing contaminants on the soil surface than range uses.

There is concern about nitrate found in the vadose zone. The vadose zone is the unsaturated area (including soils) between the surface of the land and the regional water table. Studies in Clay County by the UNL Water Center have shown that nitrates in that area are moving deeper in the vadose zone through time. The Nebraska Department of Environmental Quality has also sponsored a research study on the vadose zone.

Areas in range or a variety of native vegetation usually have less vulnerability to contamination than cropped or urban areas. Maps of both land use and native vegetation are provided in this report.

Generally there is not a strong relationship between fish and wildlife and environmental factors affecting rural/small community water supplies. Agricultural best management practices that benefit source water for rural/small community supplies may also sometimes benefit fish and wildlife. Similarly, landuse changes for wellhead protection may sometimes affect fish and wildlife.

Legal/Institutional Framework

The array of legal/institutional factors affecting rural/small community water supplies is so large that even providing a list of relevant laws and regulations can be confusing to the casual reader. Those factors are discussed at length in the report, but are beyond dealing with in detail in this summary. Legal/institutional factors can be organized into several categories: 1) the regulatory framework (including both well/water system regulation and source water protection related regulation), 2) technical assistance programs and education, and 3) funding sources. Each of those categories can further be broken down into state, local and federal government delivery categories. Private assistance is also possible in the last two categories. In most instances federal laws and regulations are in practice implemented through parallel state regulations.

In general state level regulation of public water suppliers in Nebraska is provided through the Nebraska Health and Human Services System Department of Regulation and Licensure with some related statutes being administered by the Nebraska Department of Water Resources. Private wells are subject to regulations governing water well construction but are not subject to water quality testing or water quality standards. State level source water protection regulation is generally provided through the Nebraska Department of Environmental Quality, although pesticide regulation is provided through the Nebraska Department of Agriculture. Authority for local level regulation nonpoint sources of groundwater contamination is available to the state's 23 natural resources districts. Most of the above agencies and a variety of other agencies and private entities generally provide technical assistance and education programs relevant to various aspects of public water supplies and source water protection.

In addition to community funding sources the primary government sources of funding for public wells and water systems include: 1) The Community Development Block Grant Program of the U.S. Department of Housing and Urban Development (administered in Nebraska by the Nebraska Department of Economic Development), 2) water and wastewater grants and loans from the U.S. Department of Agriculture Rural Utilities Service, and 3) the State Revolving Loan Fund portion of the federal and state safe drinking water acts (administered in Nebraska by the Nebraska Department of Environmental Quality).

Some potential discussion points, issues, problems or options associated with legal institutional factors may include:

<u>*Regulations*</u>

1) *Frequent changes in federal drinking water standards can make it difficult for a community to plan water supply improvements and can result in considerable waste of money as communities attempt to meet changing requirements through piecemeal action.*

2) *Enabling legislation to protect water sources may not be utilized at the local level, and even if it is, it may sometimes be inadequate to prevent contamination of drinking water sources.*

3) *Groundwater protection responsibilities are split between communities, NRDs, and state and federal entities.*

4) *No monitoring is required for private domestic wells nor are such existing wells required to meet water quality standards. This may save needless well owner expense but may allow contamination to go undetected.*

<u>Technical Assistance/Education</u>

5) *In the past communities sometimes adopted treatment or other water supply options without fully consulting all possible sources of assistance. There may be some need to be sure that communities are fully aware of technical assistance options and adequately explore all alternative means of addressing water supply needs.*

6) *There is no statewide program to make sure that areas upgradient of community wells (20 year time of travel or otherwise) are monitored.*

7) *Communities may not be taking full advantage of the Nebraska Wellhead Protection Program. As of late 1997 only 15 or 16 communities (out of 621 communities systems statewide) are known to have conducted contaminant source inventories. It will be important that communities take full advantage of NDEQ's Source Water Assessment Program.*

8) *It may be worthwhile to consider programs to selectively inform private well owners of testing needs and potential risks. A 1994 survey of 5,520 private well owners by the Centers for Disease Control over a nine-state region found that 44 percent of respondents indicated their well had been tested for contamination, 44 percent said their well had never been tested for contamination and 11 percent did not know. Thirty-nine percent who said their well had been tested indicated that the testing took place prior to 1990. Although private well owners in Nebraska may be better informed about potential drinking water concerns than consumers in some other states, public information efforts may be useful in some situations.*

<u>Funding</u>

9) *Provided they have not received an administrative order, some communities may still postpone needed action until either (a) better grant/loan conditions are available, or (b) the community's circumstances meet the need requirements. This can delay needed action.*

10) *The number of funding programs and their various deadlines can make application processes and coordination difficult. The Nebraska Mandates Management Initiative has a process to address this problem, but it is relatively new and not every community uses it.*

11) *A cost share program could be considered for helping phase out large diameter private domestic wells by providing assistance in constructing replacement wells. Large diameter private wells account for many of the water quality problems associated with some eastern Nebraska domestic wells.*

12) *Point of use or point of entry treatment systems could be further examined for private wells with nitrate or some other water quality problems.*

TASK 2-1 ANALYZE SOCIO-ECONOMIC, ENVIRONMENTAL AND LEGAL/INSTITUTIONAL PROBLEMS, NEEDS AND CONDITIONS

PURPOSE

This task report is intended as draft input to the Bureau of Reclamation led study "Nitrate and Nebraska's Small Community and Rural Domestic Water Supplies: An Assessment of Problems, Needs, and Alternatives. The Natural Resources Commission serves as state cost share partner and state study team member for that effort. The purpose of this task report is to provide an analysis of socio-economic, environmental, and legal/institutional problems, needs and conditions relevant to the effect of nitrate-nitrogen on rural/small community water supplies in Nebraska. Relevant information will be examined in the following order: 1) economic costs of addressing nitrate related supply problems, 2) other socio-economic factors, 3) environmental factors that may affect supply (including land use/human activities and the environmental setting), and 4) the legal/institutional framework. A brief summary of state level data is provided first, followed by more detailed information for both the state and a detailed study area that includes all or parts of Hall, Hamilton, York, Merrick, Buffalo, and Clay counties. A number of relevant factors are examined in this analysis because those tasks are assigned to the Bureau of Reclamation. Those items include: geologic conditions, water supply, technology and trend analysis (including agricultural best management practices) and supply cost.

Public Water Supply Systems

As of 1995 about 79% of Nebraska's primary source of domestic water was from public water supply systems with self supplied domestic accounting for the remainder (Figure 1) (NNRC, 1998). In 1995 domestic water use accounted for about 69% of total water use by public water systems. The remaining 31% was used for industrial, commercial, thermoelectric or other public water uses, or lost in transmission (NNRC, 1998). Groundwater supplied over 81% of publicly supplied water use in Nebraska and virtually all self supplied domestic water use. The Omaha area (Douglas and Washington counties) accounted for over 99% of the publicly supplied water use from surface water. Therefore, groundwater is overwhelmingly the source for small community supply systems. Nebraska has about 1,340 public water supply systems (NHHS, 1997). A public water system is defined as one that has at least 15 service connections or that regularly serves at least 25 individuals.

There are three types of public water systems. Community water supply systems serve at least 15 service connections used by year round residents or regularly serve 25 year round residents. They include not only city or village systems, but such entities as rural water districts,

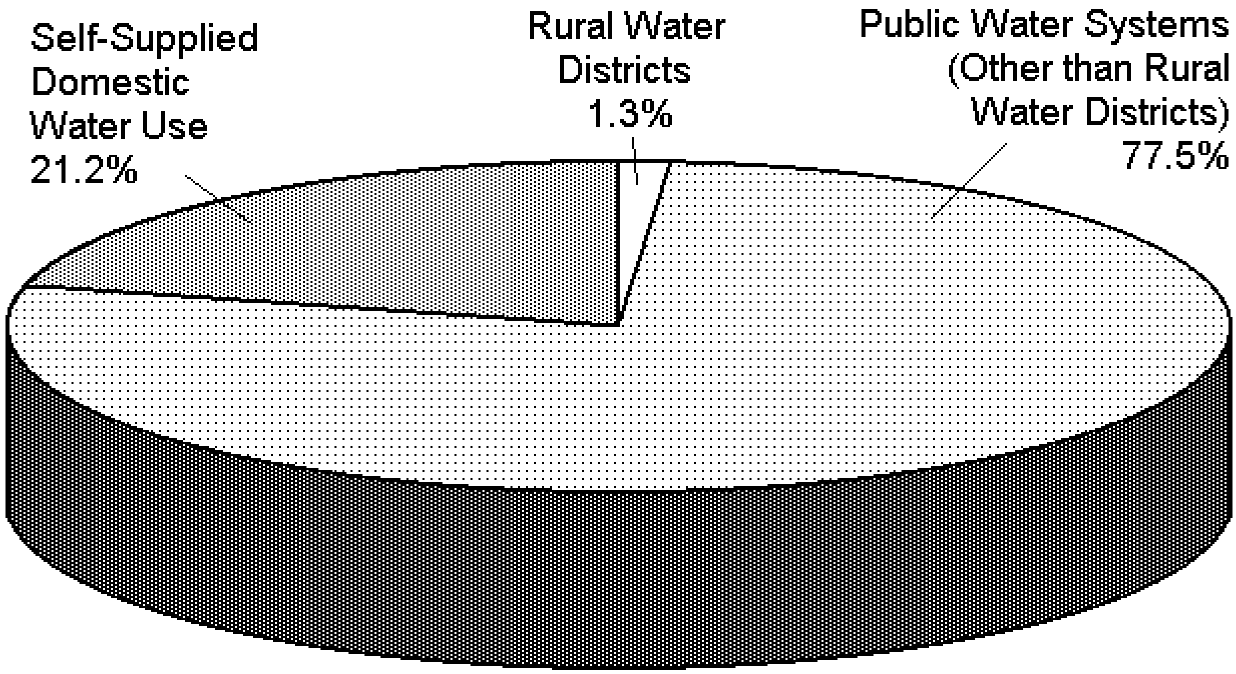


Figure 1. Percentage of domestic water use by category, 1995.

sanitary improvement districts, or mobile home parks. In 1997 there were 621 community water supply systems of which 608 serve populations of fewer than 10,000 (NHHS 1997). As of 1995 there were 521 incorporated Nebraska communities with populations of under 10,000. Fifty-nine of those communities had no public drinking water system (Keefer and Lamberty, 1995).

The other two types of public water systems are nontransient noncommunity water supply systems (185 systems) and transient noncommunity water supply systems (534 systems). A nontransient noncommunity water system regularly is a system that doesn't qualify as a community water system but regularly serves at least 25 individuals over 6 months per year. Examples could include an industrial plant with its own well or a rural school. A transient noncommunity water supply system is a public water system that does not regularly serve at least 25 of the same people over six months per year. Examples might include rest areas or a rural restaurant which has its own well.

As noted in Table 1 the combined population of towns below 10,000 (outside the MUD area) and self supplied population equals about 40% of Nebraska's population. However, those users in combination with community water systems not operated by incorporated cities or towns account for all but 13 of the 621 community water systems. Individual domestic wells supplied water for an estimated 110,754 households (Conservation and Survey Division and Nebraska Department of Health 1996).

Table 1 Community and Water Service Area Populations By Size Category – July 1, 1996 Estimates	
TOTAL STATE POPULATION – 1,648,696	
Metropolitan Utilities District Service Area Population	30.0%
Lincoln Population	12.7%
Population of Towns of Over 10,000 (Not Including MUD and Lincoln Areas)	17.5%
Rural Water Systems	1.4%
Self Supplied Population (Based on Use of 1995 Estimates of Self Supplied Population)	21.0%
*Other – Includes Population of Towns of Under 10,000 (but not including self-supplied towns, rural water systems, or areas served by MUD) plus Population of Small Community Water Systems (except rural water systems) not Affiliated with Systems of Incorporated Cities and Towns	17.4%
	100.0%

Sources: U.S. Bureau of the Census Figures – Released March 1998
Burns McDonnell, Inc. Platte River West Water Production Facilities Draft EIS 1998, prepared for Metropolitan Utilities District and U.S. Army Corps of Engineers Page 1-2 (for MUD Service Area Population Estimates)
Estimated Water Use in Nebraska; 1995 Nebraska Natural Resources Commission

NOTE: Rural water system and self supplied population figures use 1995 estimates.

* This figure was derived as a remainder after determining numbers for other categories. Actual estimated population of towns of under 10,000 in 1996 was 388,128 or 23.5% of the state's population.

Rural water systems are a special type of community water supply system that in 1995 served 22,581 Nebraskans or about 1.4% of the state's population. The 23 systems are found primarily in the eastern part of the state where availability of groundwater is less uniform. Service areas of the systems cover about 7% of the state's area and they delivered an estimated 917.68 million gallons of water in 1995 or about .88% of the state's public supplied water use (NNRC file estimates 1998). Figure 2 provides a map of system service areas. Since formation of the natural resources districts (NRDs) in 1972, new rural water systems have come under the authority of NRDs, but there is no requirement that previous districts be merged. As of early 1998 NRDs operated eight public water supply systems serving over 3,095 customers and eight small communities. One additional supply area was nearing completion.

Not all of Nebraska's small communities have a public water supply system. In 1995 Keefer and Lamberty analyzed drinking water sources and distribution systems for 521 Nebraska

Figure 2
Nebraska Rural Water Systems — November 1995

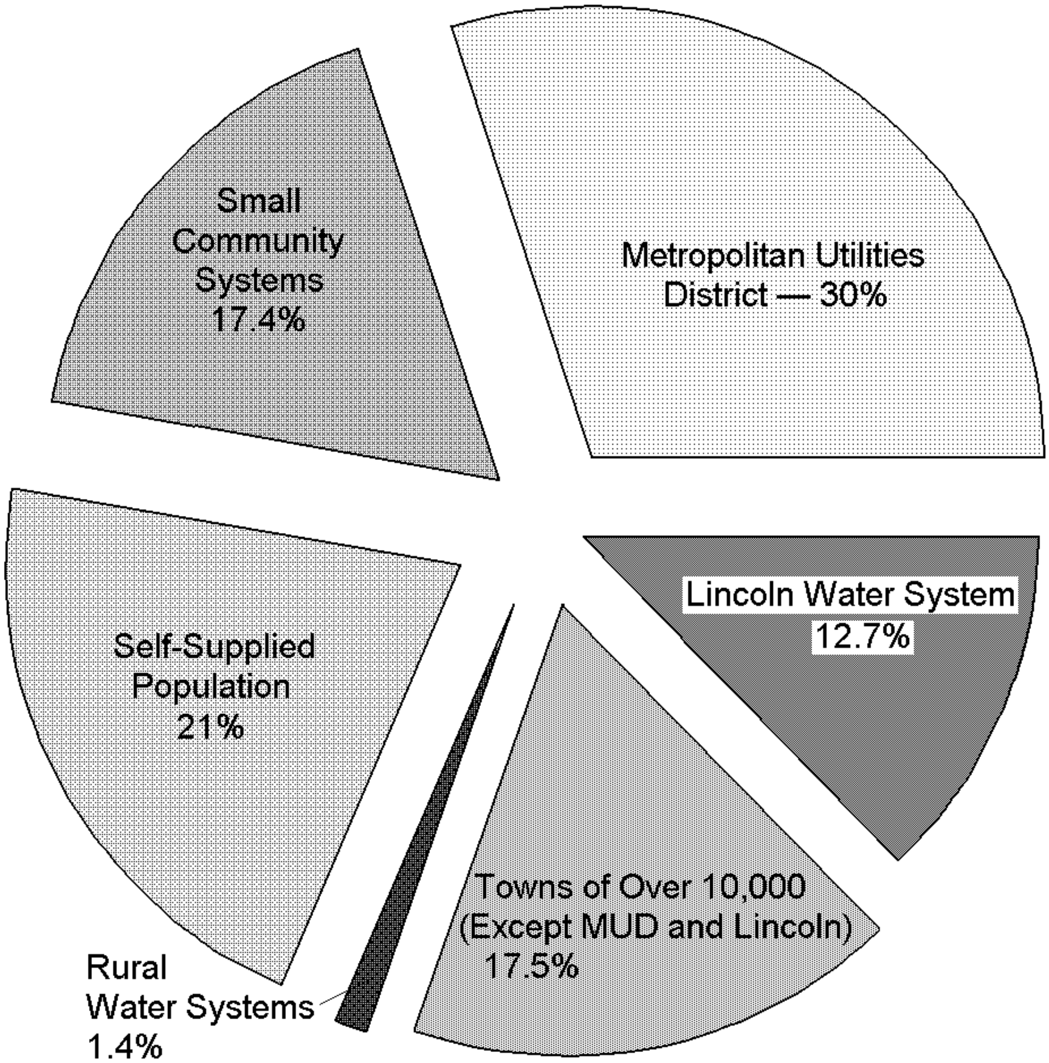
SCALE 1:3,000,000

1. Boyd County RWD1
2. Boyd County RWD2
3. Cass County RWD1
4. Cass County RWD2
5. Cedar-Knox RWD
6. Cuming County RWD1
7. Dawes County RWD1
8. Johnson County RWD1 East
9. Johnson County RWD1 West
10. Lancaster County RWD1
11. Little Blue NRD RWD1
12. Logan East RWD
13. Nemaha County RWD1
14. Nemaha County RWD2
15. Otoe County RWD1
16. Otoe County RWD3
17. Papio-Missouri River NRD RWD1
18. Papio-Missouri River NRD RWD2
19. Papio-Missouri River NRD RWD3
20. Pawnee County RWD1
21. Richardson County RWD1
22. Richardson County RWD2
23. West Knox RWD

Information Source:

Compiled by Natural Resources Commission
from information supplied by :
USDA Rural Development
Nebraska Rural Water Association
Selected Natural Resources Districts
Selected Rural Water Districts
Produced By - Natural Resources Commission
GIS Process - ARC/INFO
Processed - April 1998

Figure 2A.
Nebraska Water Service Providers by Estimated Percentage of Population Served — 1996



Sources: U.S. Bureau of the Census population figures released March 1998

Burns McDonnell, Inc., Platte River West Water Production Facilities Draft EIS, 1998, prepared for Metropolitan Utilities District and U.S. Army Corps of Engineers, p. 1-2 (for MUD service area population estimates)

Estimated Water Use in Nebraska; 1995; Nebraska Natural Resources Commission (for self-supplied population estimate). Note: the 21% figure for self-supplied population is arguable. 1990 Census of Housing reported that just under 17% of housing units had sources other than public or private company supplies.

Rural water system and self-supplied population figures use 1995 estimates.

Percentage for small community systems was derived as a remainder after determining numbers for other categories. Actual estimated population of towns of under 10,000 in 1996 was 388,128 or 23.5% of the state's population.

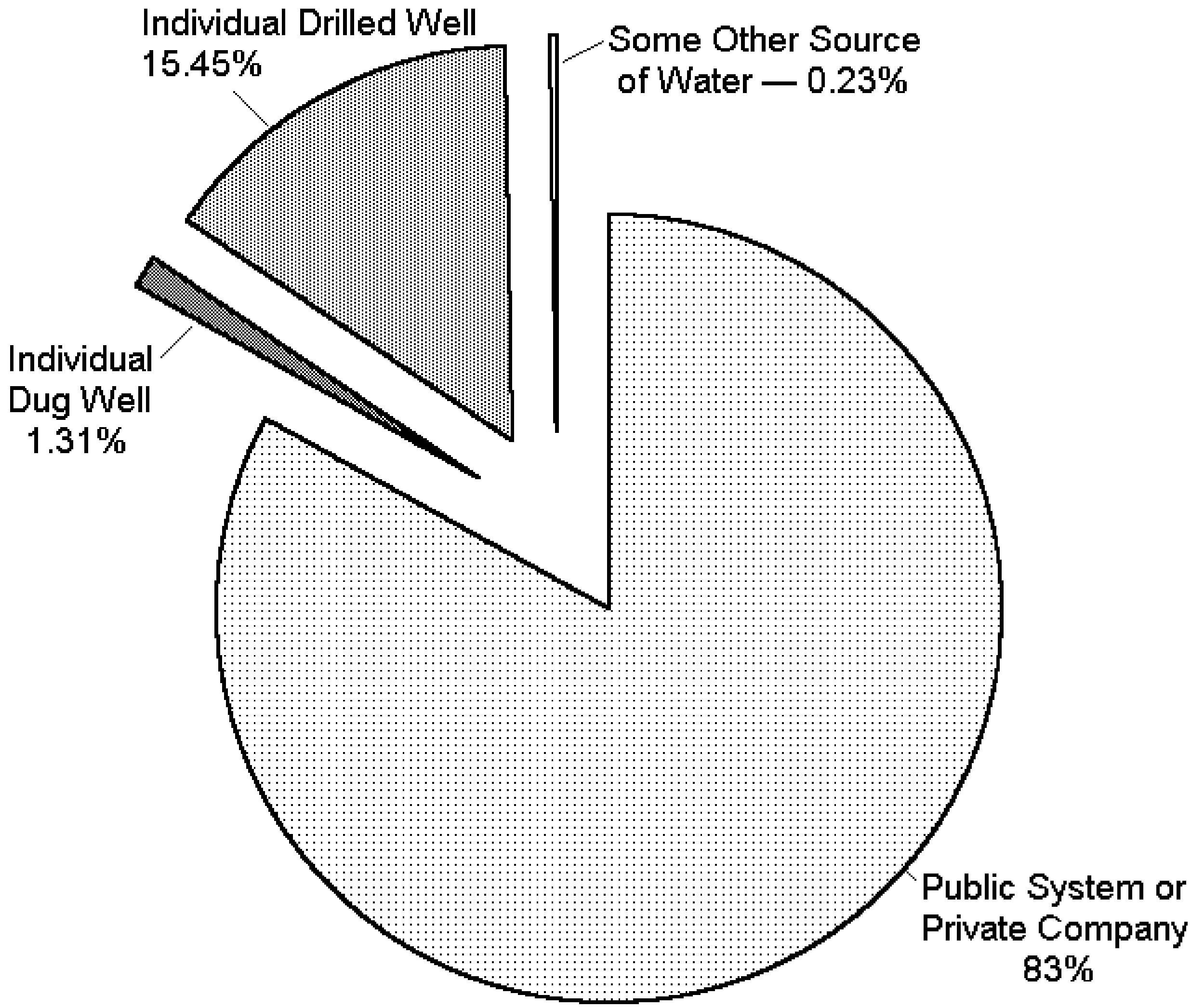


Figure 2B. Water sources for Nebraska housing units, 1990.
Source: U.S. Bureau of the Census, 1990 Census of Housing, Detailed Housing Characteristics, Nebraska, 1990, CH-2-29.

The most common major small community public water system major infrastructure expenditure in response to encountering a nitrate problem has been drilling a new well plus any transmission lines needed as a result. If there is no source of water with usable quantity and good quality in the immediate area, costs can rise as transmission lines need to become longer. In a few cases a community may even find it cost effective to go to the large expense of building a treatment plant.

A poorly sited or constructed (or shallow) well may be more susceptible to smaller point sources of contamination that don't affect a large area. Private domestic wells with older construction are more likely to be affected by construction and siting problems. Large diameter private wells in eastern Nebraska especially subject to problems. In many instances increased well depth or grouting could solve the problem. Private domestic wells that do have nitrate problems should also be checked for pesticides.

Trying to pin causal factors between well siting and nitrate sources for either public water systems or private domestic wells is a difficult and perhaps subjective matter. Theoretically, a truly poorly sited well might be a shallow well at the only contaminated level of the only contaminated part of a large aquifer. On the other hand in very contaminated areas or areas with a limited shallow aquifer, it may theoretically be impossible to find an area of uncontaminated aquifer for a some distance. In between those two extremes are a large array of potential relations between well site and nitrate sources. In instances where nitrate sources have increased, older, poorly sited wells might be most likely to be affected or be affected first. This task report did not examine the age, depth, or construction of the public water supply wells that had high nitrate readings and were replaced or relegated to backup status.

Domestic Well-Water Quality in Nebraska (UNL Conservation and Survey Division and Nebraska Department of Health 1996) identified a number of factors which could influence occurrence of contaminants in domestic wells. Those factors generally are also applicable to public water wells and are worth repeating here. They include: "well construction factors, which include: casing type, installation date (age), diameter, well completed in or out of pit, sanitary seal, and well type; distance factors, which include distance to cesspool, septic systems, waste lagoons, barnyards, pasture, and cropland; and hydrologic and site factors, which include: well depth, depth to water, landscape and soil characteristics, and nearby chemical use."

Domestic Well Registrations

Nebraska statutes have only required registration of new domestic wells since 1993. Full calendar year data is available for only four calendar years since that time. New registrations per year in that interval were:

1994 – 1024
1995 – 1219
1996 – 1359
1997 – 1442

Although the period of record is too short to draw strong conclusions, there does seem to be a gradual rise in well registration numbers. There are no reliable numbers on how many private domestic wells are abandoned each year. The total number of private domestic wells in use are perhaps best indicated through U.S. Bureau of the Census figures (Census of Housing 1990) showing that individual domestic water wells supplied water to 110,754 households in Nebraska in 1990.

Census Data on Water Sources

The 1990 Census of Housing indicated that individual domestic water wells supplied water to 110,754 Nebraska households in 1990. This represented nearly 17% of the state's

660,621 housing units. Public systems or water supplied by private companies accounted for 548,285 units, or about 83% of total housing units. Other sources of supply accounted for about 1,582 housing units, or about ¼% of the total. Dug wells accounted for almost 8% of the total households supplied by individual wells, while drilled wells accounted for the remainder.

The census data indicating less than 17% of the state's households supplied by individual drilled or dug wells in 1990 is significantly less than the 21% figure for self supplied population provided in the Natural Resources Commission (NNRC) report *Estimated Use of Water in Nebraska, 1995.* This may be in part because the Census Bureau's "Public System or Private Company" category includes any housing groupings with five or more connections whereas the "public water system" definition used in the NNRC report involves systems with at least 15 service connections or serving at least 25 individuals. Also the Census data includes vacant housing units and may involve different average numbers of household members. Still the discrepancy between the two sources seems large.

NNRC Water Use Estimate Data on Water Sources

The NNRC data on water use were developed by surveying public water suppliers, estimating numbers served for those not responding, and allocating the remaining county population to the "self supplied" category. In 1990 this resulted in an estimate of 377,600 of the state's 1990 census population of 1,578,385 being self supplied, or 23.9% of the population. In 1995 the data indicated that an estimated 346,400 of the state's population were self supplied out of a total population of 1,637,100, or 21.2%.

Self-Supplied Domestic Use Estimate for Report on *Domestic Well-Water Quality in Rural Nebraska*

Domestic Well-water Quality in Rural Nebraska (CSD/NDOH April 1996) stated "According to this study, it is estimated that an average of 3 people use each domestic well. Multiplying this number by the 110,754 households using rural domestic supplies indicates that nearly 332,262 individuals may be affected by the quality of rural drinking water in Nebraska. This represents about 20% of Nebraska's population".

Economic Costs of Addressing Nitrate Related Supply Problems in Small Community and Rural Water Supplies

Some of the following sections are intended to help illustrate the rough magnitude of nitrate related infrastructure costs and place them in perspective with other community and rural domestic water supply costs.

<u>Abbreviated Summary</u>

Data compiled for this report indicate that since 1981 fifty-eight small Nebraska cities and villages have built or are in the process of constructing nitrate contamination related drinking water projects with a total estimated final cost of $24.7 million. In some ways this figure is overstated, because nitrate was only one of the reasons some of the projects were built. However, it should also be noted that monitoring as well as operation and maintenance of treatment facilities are not included in this figure. If the total amount is inflation adjusted into 1997 dollars it becomes about $28.1 million. The small cities, villages and rural water systems had a combined population of 60,091 and on that basis paid an average per capita amount of about $410 for the improvements. Projects submitted for NHHS review and approval (1996 or later account for over 7 million of the total.

In comparison to overall water system expenditures or an EPA survey of water system infrastructure needs, this number is small. Figures compiled for this report indicate that in 1996 and 1997 combined small city, village and rural water system nitrate contamination related drinking water system projects accounted for only 8.8% of total small community water project (including water main) construction approved by the Nebraska Health and Human Services System. Of the 55 public water wells approved for construction during that period, 16 were for projects related to nitrate contamination. In 1995 the U.S. Environmental Protection Agency estimated Nebraska's total 20 year need for water system infrastructure at almost $953 million. At $472.2 million, small systems (serving fewer than 3,300 in the EPA study) accounted for nearly half of the 20 year Nebraska infrastructure need. EPA estimated 20 year total Nebraska Safe Drinking Water Act needs related to nitrate at only $8.4 million and total Safe Drinking Water Act related needs at over $184 million.

a) Costs of Nitrate Related Infrastructure vs. All Public Water System Infrastructure

<u>Estimated Costs of All Public Water Supply Projects Approved in 1996 and 1997 vs. Nitrate Related Problems</u>

A number of factors can account for community's decision to expand water supply infrastructure. Increased demand, changes in water quality, changes in water quality standards, decay of existing infrastructure, or depletion of supply can all affect infrastructure needs. In turn demand can be influenced by increasing or decreasing population, the needs of various industries, water rates, or water conservation efforts.

Plans and specifications for all major public water supply system construction or alteration must be submitted to the Nebraska Health and Human Services System for review and approval prior to contracting/construction. A review fee for those projects is based in part upon the engineer's estimate of the cost of the project.

For the period of January 1, 1996 to December 31, 1997 the Nebraska Health and Human Services System received project review fees from 301 separate water systems of all sizes. Based upon the fees submitted, those projects had a total estimated cost of $39,621,782. Analysis for this study indicates that the 10 systems that appear to have built or be in the process of building projects at least partially related to nitrate problems account for about 3,486,190 or about 8.8% of the estimated project costs. Although amounts for projects approved do differ from projects received, that difference is small. All figures were calculated using the preproject engineers estimates submitted with the application. These were of ten considerably lower than the amounts supplied by communities responding to the survey or Community Development Block Grant files. In addition two major projects were begun after the 1996-1997 period and were not included in this amount. Thus, the total expenditure of over $8 million in projects applied for in 1996 is about double the amount indicated in the tables used to derive the above figures.

Much of the total cost experienced by water systems is for water mains. A total of 202 of the 301 projects included water mains. If only projects where a community put in a new well are considered, a different picture emerges. Health and Human Service System files indicate that community water system projects approved in 1996 and 1997 involving new wells included construction of 61 wells and 5 treatment plants as well as expenditures for storage facilities, water mains and other improvements. Nitrate related small city, village or rural water system projects involved about 16 of the 61 wells and one treatment project.

Table 2 presents a combined summary of all projects received for NHHS review in calendar years 1996 and 1997.

Table 2
Public Water Supply Projects Received for NHHS Review
Calendar Years 1996 and 1997 Combined

# of Projects Received	301
# of Projects Approved	298
Wells	55
Mains	302
Booster Pumps	9
Storage Facilities	20
Treatment Plants	4
Chemical Feeds	---
New Swimming Pools	---
Pool Changes	---
Septic Tanks	---
Mobile Home Parks	---
Other	25

1995 EPA Drinking Water Infrastructure Needs Survey – Nebraska Data

In January, 1997 the U.S. Environmental Protection Agency issued a report entitled *Drinking Water Infrastructure Needs Survey, First Report to Congress* (U.S. EPA, 1997). That report estimated monetary costs of future water system infrastructure needs in a variety of categories by state. It estimated Nebraska's total Safe Drinking Water Act and Safe Drinking Water Act (SDWA) related needs for nitrate over the following 20 years at $8.4 million (in January 1995 dollars). That ranked Nebraska fourth in the nation in nitrate related needs, following California, Illinois and Oklahoma. California accounted for $172 million of the nation's 273.7 in nitrate related infrastructure needs.

The $8.4 million of Nebraska infrastructure needs to address nitrate represents less than 5% of the $184.1 million in Nebraska SDWA related needs expected over the ensuing 20 years and is considerably under the nitrate related rough estimates for infrastructure this report has generated for the 1981 to 1997 time period. It also represents less than 1% of the total Nebraska twenty-year drinking water infrastructure need of $952.9 million. However, it should be kept in mind that "needs" are higher than current expenditures on infrastructure. At $472.2 million, small systems (serving fewer than 3,300 in the EPA study) accounted for nearly half of the 20 year Nebraska infrastructure needs. Nebraska related data from EPA's Drinking Water Infrastructure Needs Survey are presented in Table 3. The nationwide survey was compiled from sample communities in each state. In Nebraska 36 communities were used to help compile the data.

Future Costs of Other Contaminants

Nitrate accounted for nearly half of water quality violation administrative orders in the 1991 to 1997 time period with a total of 34 of the total 69 administrative orders issued. Changes in EPA standards related to a range of contaminants/problems may result in nitrate accounting for a relatively smaller portion of administrative orders, even if the actual number of nitrate related administrative orders were to remain the same. Requirements related to lead, copper, arsenic, radon and potentially in the future, mandatory disinfection may result in the need for system improvements in some small communities.

For instance, as of mid-1998, 64 Nebraska community water systems were under administrative order from the Nebraska Health and Human Services System to bring copper levels under an EPA required level of 1.3 milligrams per liter. This high number of administrative orders is occassioned by EPA's adoption of new requirements rather than by systems rising above previous requirements. Although the 1995 EPA infrastructure needs inventory estimated the 20-year cost of compliance with the lead and copper rule at only $4.3 million there is reason to believe that may be a very substantial underestimate. For instance, it was estimated that the rule would cost the City of Hastings alone $1 million in water treatment equipment initially plus $250,000 per year. It seems likely that this new requirement and other potential requirements such as mandatory disinfection could eventually result in very substantially increased infrastructure costs for Nebraska small communities.

b) Estimated Economic Costs of Addressing Nitrate Related Community Water System Supply Problems Since 1981

Use of data from multiple sources combined with a survey of Nebraska communities believed to have made nitrate related expenditures allowed compilation of a rough estimate of economic costs since 1981.

Table 3.—Nebraska Related Data From Drinking Water Infrastructure Needs Survey
First Report to Congress
U.S. EPA – January 1997
(In Millions of January 1995 Dollars)

	Nebraska Drinking Water Infrastructure Need by Category					
	Transmission and Distribution	Treatment	Storage	Source	Other	Total
Total Need (20 Year Need in Millions of January 1995 Dollars)	471.3	306.4	78.1	90.7	6.3	952.9
Current Need	254.8	176.7	48.2	69.8	0.0	549.5

	Nebraska Safe Drinking Water Act and Safe Drinking Water Act Related Needs (Existing Regulations)							
	Surface Water Treatment Rule	Total Coliform Rule	Nitrate Standard	Lead and Copper Rule	Phase I, II, and V Rules (Chemical Contaminants)	Total Trihalomethanes Standard	Other Standards	Subtotal
Current SDWA Need	156.1	1.1	8.4	2.3	1.1	0.0	0.2	169.2
Total SDWA & SDWA Related Need (20 Year Need in January 1995 Dollars	168.8	1.4	8.4	4.3	1.1	0.0	0.2	184.1

Nebraska Total Safe Drinking Water Act and Safe Drinking Water Act Related Needs				
Proposed Rules				SDWA Related Need
Disinfection and Disinfection Byproducts Rule	Enhanced Surface Water Treatment Rule	Information Collection Rule	Subtotal	Distribution Improvement (Total Coliform Rule)
33.0	7.2	0.1	40.3	262.9

Nebraska Total Infrastructure Need by System Size (20 Year Need in January 1995 Dollars)			
Small Systems (Serving 3,300 or Fewer People)	Medium Systems (Serving 3,301 to 50,000 People)	Large Systems (Serving More Than 50,000 People)	Total
472.2	250.1	230.6	952.9

As of 1997 Nebraska had a total of 608 community water supply systems serving under 10,000 people. Records indicate that since 1981 at least 59 Nebraska small city, village or rural water systems have improved or are improving their water systems. The total cost of at least partially nitrate related water projects completed or underway is estimated to be over $24 million.

The nature of the available data makes it possible that a few systems were missed in compilation of this data. There were also some instances where a project was left out because it was not confirmed whether or not it was nitrate related. Thus, in that sense, the above estimates are likely understated.

However, determination of what is a “nitrate related” project is also difficult and may result in overstatement. Available files generally do not characterize a project as “nitrate related.” Nitrate may be only one of the factors that may result in a community decision to upgrade its water system. When a system is upgraded, some features of the project may have little to do with nitrate. For purposes of this summary all project costs for any project where nitrate appears to be at least one of the major factors that resulted in project construction is included in the data.

Table 4 provides a summary of some of the nitrate related data on community water systems gathered for this study. Table 5 provides estimates of project costs by community system for projects that appear to be at least partially nitrate related. Because in some instances pre-project engineer’s estimates from Health and Human Service System files are used, amounts may vary from final project costs. It should also be noted the estimated final costs for projects underway but not yet completed are included. Figure 3 provides a map of cities or villages that have made or are making water system improvement projects that appear to be at least partially related to nitrate in Drinking Water Supplies. It is possible that a few communities were left off of this compilation due to data compilation difficulties. Figure 3A provides a rough summary of costs by year.

Significant maintenance costs for communities which built water treatment systems in response to nitrate problems would push overall cost figures higher. There are also increased sampling costs for communities which are required to sample on a quarterly basis as a result of elevated nitrate levels. Communities which exceed a 5 mg/l monitoring trigger at their point of entry must sample on a quarterly basis until readings have been under 8 mg/l for four consecutive quarters. As of January 1998 it cost $18.10 to have a sample analyzed for nitrate-nitrogen by the Nebraska Department of Health and Human Services.

Table 4. — Small City and Village Water System Project Costs — Projects for Which Nitrate Was One of the Major Reasons for Initiating the Project

(Current as of May 1998; Community Systems Serving Under 10,000 People Only)

# of Community Water Systems Serving Under 10,000 People (1997) – 608

# of Community Water Systems That are Small City or Village Systems – 451

# of Small City and Village Community Water Systems Where a Point of Entry or the System Has Had One or More Samples Above 5 ppm Nitrate-Nitrogen Since 1981 – 296* (through 1998)

# of Small City and Village Community Water Systems Where a Point of Entry or the System Have Had One or More Samples Above 10 ppm since 1981 – 168* (through 1998)

% of Water Quality Violation Administrative Orders Related to Nitrate 1991-1997 - 49% (34 of 69)

# of Nitrate Related Administrative Orders Issued 1981 to March 1998 – 74

# of Small Community Water Systems Receiving Nitrate Related Administrative Orders – 1981 to March 1998 – 62

# of Small Cities, Villages and Rural Water Systems Receiving Nitrate Related Administrative Orders (1981-1997) Which Later Made Nitrate Related Infrastructure Improvements – 36 (also another 5 community water systems not related to incorporated cities and villages, or rural water systems)

# of Community Systems That Received Nitrate Related Administrative Orders 1981–1997Where No Record Found of Major Nitrate Related Infrastructure Improvement (Note: Only 9 of these were incorporated city or village operated systems) – 21

# of Small City, Village or Rural Water Systems That had no Administrative Orders but made Substantial Infrastructure Improvements That Appear to be Related to Nitrate – 23

Approximate Nitrate Related Infrastructure Project Expenditures for Small City, Village or Rural Water Systems Receiving a Nitrate Related Administrative Order Since 1981 (Including Estimates for Projects Underway) – $11,283,298 (includes total costs of projects for which nitrate was one of the major reasons or the major reason for initiating the project)

Rough Related Infrastructure Project Expenditure Estimate for All Small City, Village or Rural Water Systems Making Nitrate Related Infrastructure Project Expenditures Since 1981 (Including Estimates for Projects Underway) (includes total costs of projects for which nitrate was one of the major reasons or the major reason for initiating the project)) – $24,667,600

Total 1998 Population of Small Cities and Villages Which Have Made Nitrate Related Infrastructure Project Expenditures Since 1981 or Currently Have Such Projects Underway – 60,091

Estimated Final Per Capita Costs of Nitrate Related Infrastructure Improvement Projects Completed or Underway for Small Cities and Villages Making Improvements Since 1981 – $410

Inflation Adjusted Total Cost of Nitrate Related Infrastructure Improvement Projects 1981 Through 1998 in 1998 Dollars (including estimates for projects underway) Includes Total Costs of All Projects for Which Nitrate Was a Major Reason or the major Reason for Initiating the Project – $28.1 million

Nitrate Related Projects Accounted for This % of Overall Estimated Cost of Water Projects Approved in 1996 and 1997 – 8.8%

\- -

*It is not known how complete available records are. Therefore, it is possible that readings above these respective levels may have been experienced by additional community systems.

TABLE 5

Estimated Cost of Nitrate Related Infrastructure Completed or Underway by Small Cities, Village and Rural Water Systems 1981 – early 1998

[Compiled from a survey conducted for this study and from the records of the Nebraska Health and Human Services System and the Community Development Block Grant Program. Includes projects submitted for HHSS review in 1997 or early 1998 but for which actual construction may not have begun. Surveys were sent to 87 small city or village water systems which (1) had a nitrate sample over 5 mg/L since 1981 or had a nitrate related administrative order, and (2) were identified as having undertaken a subsequent water-supply project that may have been related to nitrate. Responses came back from 79 small cities or villages. A final list was developed that included 59 communities identified as having made nitrate-related water-system expenditures. That list includes five villages that were unconfirmed (four of which made improvements subsequent to receiving an administrative order). It also includes one village that did not receive a survey but was installing its first water system. Three villages that had received no administrative order and did not respond were excluded from the final list. The listed sources of cost data do not denote funding sources. While figures used are not exact, in the composite they provide a rough estimate of total project costs.]

Record of Administrative Order	HHSS Review Year[1]	Completion Year	Name of System	Population (1996)	Cost	Source of Cost Data[2]	Cost per Capita	ENR Index[3] Start year +1	Cost In 1997 Dollars
AO	1989	1991	Adams[4]	476	$ 399,000	CDGB/TOWN	$ 838.24	4732	$ 491,246
AO	1987	1989	Bartley	333	$ 106,072	TOWN	$ 318.53	4519	$ 136,750
AO	1996		Bazile Mills	35	$ 118,500	HHSS/TOWN	$ 3,385.71	5826	$ 118,500
AO	1987		Belden	146	$ 105,000	HHSS/TOWN	$ 719.18	4519	$ 135,368
	1996		Benkleman[5]	1071	$ 705,491	TOWN	$ 658.72	5826	$ 705,491
AO	1988	1992	Bradshaw[6] (unconfirmed)	343	$ 381,600	CDGB	$ 1,112.54	4615	$ 481,734
AO		1982	Bruning	324	$ 200,000	TOWN	$ 617.28	3535	$ 329,618
AO		1998	Brunswick	170	$ 503,900	CDGB/TOWN	$ 2,964.12	5826	$ 503,900
AO	1985	1988	Burwell	1250	$ 240,000	TOWN	$ 192.00	4295	$ 325,551
	1997		Central City	2906	$ 107,000	HHSS/TOWN	$ 36.82	5826	$ 107,000
	1997		Chapman[7]	296	$ 1,245,600	CDGB	$ 4,208.11	5826	$ 1,245,600
AO	1989	1993	Creighton[4,8]	1149	$ 1,035,000	CDGB/TOWN	$ 900.78	4732	$ 1,274,284
AO		1984	Danbury	107	$ 176,000	CDGB/TOWN	$ 1,644.86	4066	$ 252,183
	1997		Deshler	833	$ 200,000	TOWN	$ 240.10	5826	$ 200,000
	1990		Diller[9]	297	$ 260,000	TOWN	$ 875.42	4835	$ 313,291
AO	1985	1988	Dodge	686	$ 92,083	TOWN	$ 134.23	4295	$ 124,907
AO	1984		Duncan[6] (unconfirmed)	372	$ 148,500	CDGB	$ 399.19	4195	$ 206,236
AO	1989	1992	Edgar[6] (unconfirmed)	636	$ 168,800	CDGB	$ 265.41	4732	$ 207,825
AO	1990		Elmwood[4]	611	$ 486,948	CDGB/TOWN	$ 796.97	4835	$ 586,755
AO	1990	1992	Funk	202	$ 422,300	CDGB/TOWN	$ 2,090.59	4835	$ 508,856
	1986		Genoa	1069	$ 499,500	CDGB/TOWN	$ 467.26	4406	$ 660,483
AO	1996		Gibbon	1473	$ 875,605	TOWN	$ 594.44	5826	$ 875,605
AO	1986	1989	Goehner	192	$ 159,500	CDGB/TOWN	$ 830.73	4406	$ 210,905
AO	1989	1992	Hampton	418	$ 409,400	CDGB/TOWN	$ 979.43	4732	$ 504,050

	1992		Hardy[4]	199	$ 396,200	CDGB/TOWN	$ 1,990.95	5210	$ 443,044
AO	1986	1988	Hickman	1150	$ 297,700	CDGB/TOWN	$ 258.87	4406	$ 393,645
AO	1986		Hildreth[6] (unconfirmed)	361	$ 92,000		$ 254.85	4406	$ 121,650
	1997		Hordville[10]	168	$ 245,000	HHSS/TOWN	$ 1,458.33	5826	$ 245,000
	1987	1992	Howells[11]	687	$ 665,000	CDBG	$ 967.98	4519	$ 857,333
AO	1985	1989	Indianola	630	$ 309,896	TOWN	$ 491.90	4295	$ 420,362
AO	1985	1988	Johnson	333	$ 205,312	TOWN	$ 616.55	4295	$ 278,498
AO		1985	Lebanon	72	$ 222,000	CDGB/TOWN	$ 3,083.33	3825	$ 338,136
AO	1985		Liberty	75	$ 52,650	HHSS/TOWN	$ 702.00	4295	$ 71,418
AO	1986	1988	Martinsburg	93	$ 32,000	CDGB/TOWN	$ 344.09	4406	$ 42,313
AO	1988	1995	McCook	7926	$ 780,000	CDGB/TOWN	$ 98.41	4615	$ 984,676
	1992		Mead	535	$ 70,000	HHSS/TOWN	$ 130.84	5210	$ 78,276
AO	1986	1988	Milford	1989	$ 235,800		$ 122.62	4406	$ 322,485
	1990	1992	Obert	38	$ 40,000	TOWN	$ 1,052.63	4835	$ 48,199
	1996		Otoe CoRWD	2294	$ 255,290	HHSS/TOWN	$ 111.29	5826	$ 255,290
	1992		Overton[12]	766	$ 422,800	HHSS	$ 551.96	5210	$ 472,789
AO	1992	1994	Page[4]	182	$ 380,000	TOWN	$ 2,087.91	5210	$ 424,929
AO		1998	Paxton	523	$ 1,164,000	TOWN	$ 2,225.62	5826	$ 1,164,000
AO	1991		Pickrell[6] (unconfirmed)	205	$ 72,440	HHHS	$ 353.37	4985	$ 84,661
	1993		Pleasant Dale	250	$ 116,000	CDGB	$ 464.00	5408	$ 124,966
	1993		Rockville[13]	115	$ 356,586	HHSS	$ 3,100.75	5408	$ 384,148
AO	1993		Royal	75	$ 50,000	CDGB	$ 666.67	5408	$ 53,865
	1996		*(Seward[14])* *see final note*	*(6093)*	*($ 1,928,000)*	*(HHSS/TOWN)*	*($ 316.43)*	*(5826)*	*($ 1,928,000)*
	1992		Sidney	6128	$ 1,500,000	HHSS/TOWN	$ 244.78	5210	$ 1,677,351
AO	1985		Sprague	150	$ 85,000	TOWN	$ 566.67	4295	$ 115,299
	1997		Springview[15]	297	$ 435,328	TOWN	$ 1,465.75	5826	$ 435,328
	1995		St. Paul[4]	2181	$ 3,250,874	TOWN	$ 1,490.54	5620	$ 3,370,034
	1989		Sterling	449	$ 69,800		$ 155.46	4732	$ 85,937
AO	1986		Utica	752	$ 115,708	CDGB/TOWN	$ 153.87	4406	$ 152,999
AO	1989		Wilcox	359	$ 297,000	CDGB/TOWN	$ 827.30	4732	$ 365,664
AO	1988		Wilsonville	140	$ 378,600	CDGB/TOWN	$ 2,704.29	4615	$ 477,947
	1983		Winnetoon	60	$ 95,700	CDGB/TOWN	$ 1,595.00	4146	$ 134,479
	1996		Wisner	133	$ 154,133	TOWN	$ 1,158.89	5826	$ 154,133
AO	1985	1987	Wood River	1257	$ 562,900	CDGB	$ 447.81	4295	$ 763,552
	1996		York	8146	$ 280,000	HHSS/TOWN	$ 34.37	5826	$ 280,000
			TOTAL	60,091	$ 24,667,600		$ 409.72		$ 28,056,574

Footnotes for Table 5.

[1] Some projects had more than one review year. In those cases the latest one is given.
[2] CDGB, Community Development Block Grant files. HHSS, Nebraska Health and Human Services System files.
[3] Engineering News Record cost index for the year following the project's starting year.
[4] Built a treatment facility.
[5] Survey response noted "nitrate was one of the reasons – however, the quantity of water that could be pumped from existing wells was probably a more important factor."
[6] Not confirmed, but town did receive an administrative order for nitrates and made improvements shortly thereafter.
[7] Town had no community water system. Installation is occurring in part due to nitrate in individual wells. No survey was sent to this town.
[8] Creighton survey response specifically noted that nitrate was the only reason for the treatment plant.
[9] Telephone follow-up survey of Diller indicated that nitrate was a contributing factor, as well as manganese and pumping clay.
[10] Hordville expenses were first for carbon tetrachloride problem, but then nitrate problem also from survey response indicated total cost would likely be for considerably over $245,000, but overall figure not available.
[11] Howells project not yet complete and town survey response noted final cost was expected to be $780,000 to $850,000.
[12] Overton indicated well replacement around 1982 as well, also due to nitrate. Also storage was improved at that time.
[13] Town not contacted. However, town installed water system due to nitrate in individual wells.
[14] *Seward survey response also noted "projected water treatment at $4,500,000." Only $1,928,000 project submittal to HHSS in 1996 was used in this table. However, as of June 1999 action on a treatment system was postponed. It is therefore arguable that this entry should not be included in this table. However, it has been included in table and summary statistics.*
[15] Nitrate only one factor. Town put in extensive mains, hydrants and other infrastructure as well.

In addition to the small city, village and rural water systems included in this table, some evidence was found that at least an additional 5 community water systems that received administrative orders and were not operated by cities or villages made improvements with a cost of $176,542 over the period. Those amounts are not included in the totals in this table.

No Survey Response – Not Included

It is not known whether the following communities made infrastructure improvements in response to nitrate. They are therefore not included in the summary statistics. All of these communities had a nitrate reading above 7 ppm and later made system improvements after which nitrate levels dropped. However, none of the communities received administrative orders. In the survey of communities with similar characteristics a majority of the changes were not nitrate related. No survey response was received from these towns.

Community	Year of Project Initiation	Cost
Cody	1983	$375,850
Elk Creek	1997	$27,507
Fullerton	1994	$18,000

Unsurveyed Nonmunicipal Systems

West Park Plaza	$20,000
Mobile Manor	$18,000
Green Acres Mobile	$5,600

Sources: Nebraska Health and Human Services System – Public Water System Files (HHSS)

Nebraska Department of Economic Development – Community Development Block Grant Files (CDBG)

Natural Resources Commission Survey of 92 Selected Small City and Village Water Systems

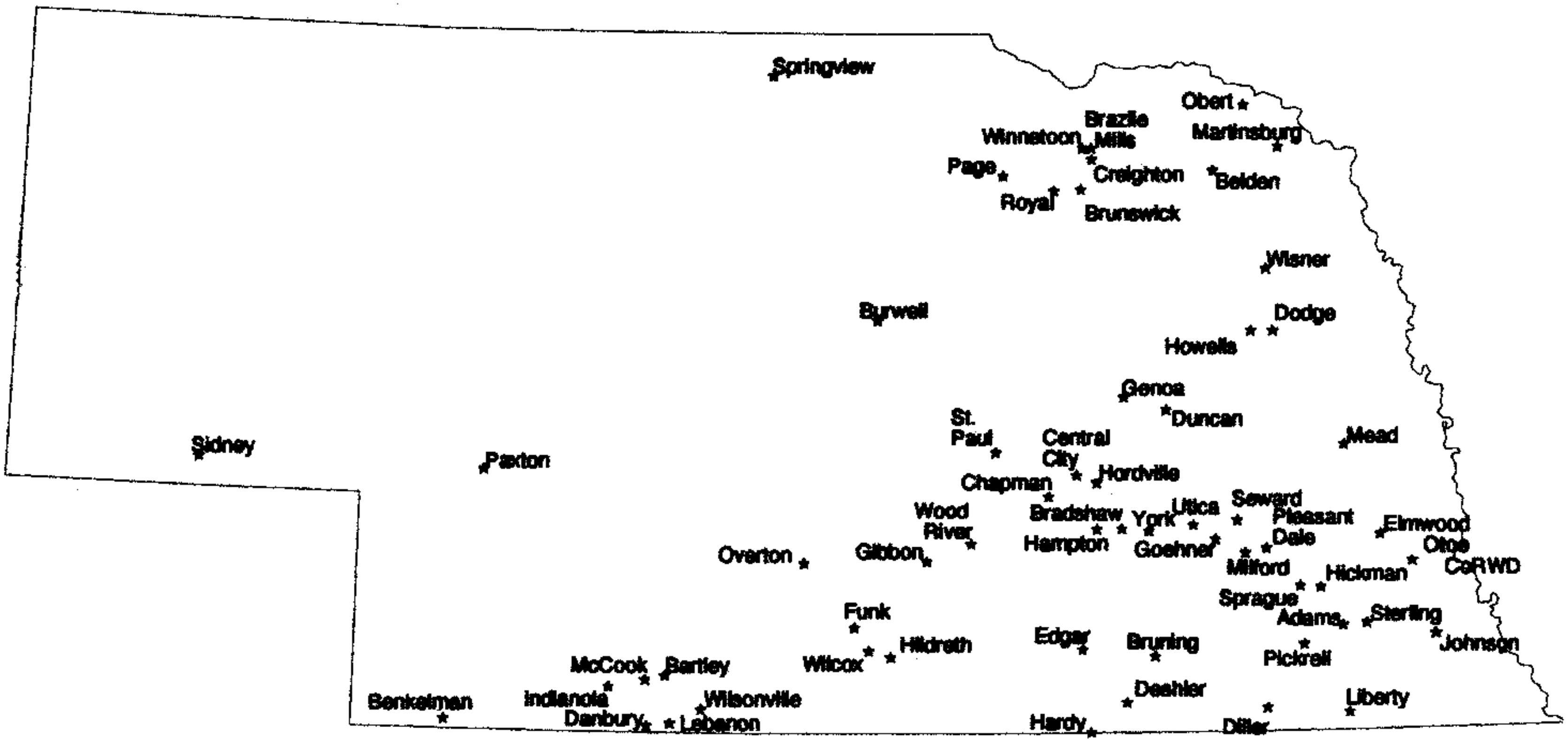
Table Compiled by Nebraska Natural Resources Commission

Figure 3

SMALL CITIES OR VILLAGES OF 10,000 OR LESS

Which had Major Nitrate Related Community Drinking Water System Infrastructure Projects Completed or Underway 1981 - 1997

(Includes projects approved in 1997 but for which construction may not begin until later)



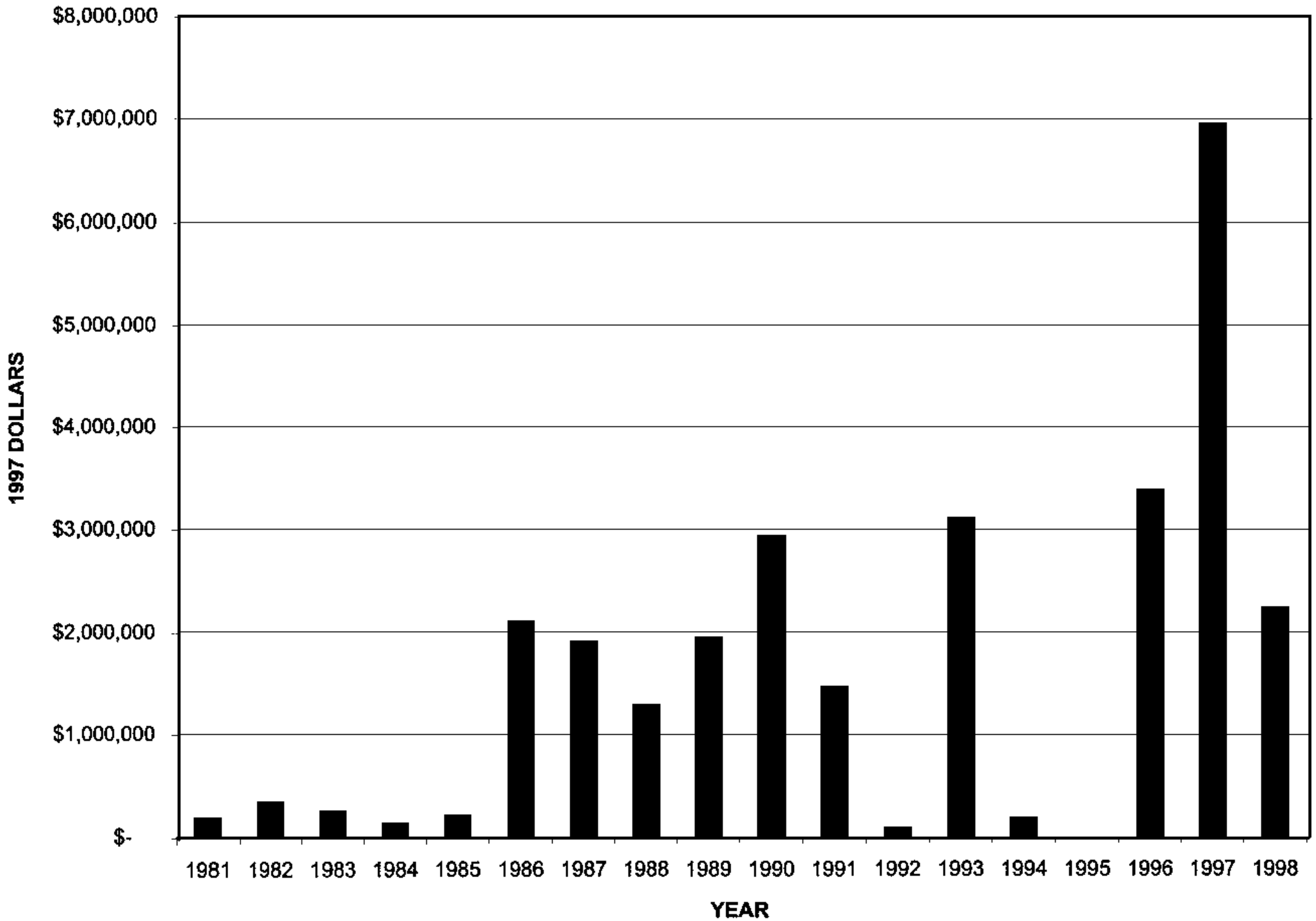
Information Sources:

Nebraska Health and Human Services System
Public Water System Files
Nebraska Department of Economic Development
Community Development Block Grant Files
Survey of 92 Nebraska Communities by Nebraska
Natural Resources Commission
Produced By - Natural Resources Commission
Cities - TIGER Files
GIS Process - ARC/INFO
Processed - August 1998

*Communities included, with a few exceptions, either responded to a survey or had received an administrative order and subsequently under took improvements. In some instance communities may have simultaneously undertaken other drinking water infrastructure improvements or improved a system more than was needed to address the nitrate problem. Insufficient information was available to exclude those types of expenditures from this table. Community water systems other than cities or villages are not included on this map.

Figure 3A

Rough Adjusted Annual Cost of Nitrate Related Projects by Small City, Village and Rural Water Systems. 1982-1998 includes projects reviewed by NHHS but not yet built.*



***Assumes all project costs come in the year after project review by NHHS or in few cases in year prior to project completion.**

The most significant single cost impact from nitrates may come if they result in a community needing to treat its water. Lamberty and Keefer (1995) noted that as of that time "only 44 of the 425 towns with wells treat their drinking water; 28 disinfect, 5 treat for nitrates, and 21 remove iron and manganese." Most (282) of those towns had multiple wells but no common distribution system. The costs of going to treatment, whether for nitrate or other causes can be very high for such communities, much higher than the cost of only drilling a new well.

Available data seem to indicate that since 1981 seven Nebraska small cities or villages have built or undertaken nitrate related projects that have included new water treatment facilities. The cost of that infrastructure was about $6,933,512. These seven small cities or villages constitute about 12% of the 59 total communities that have made or are making nitrate contamination related drinking water infrastructure improvements. However, they constitute about 28% if all nitrate related infrastructure improvement over that period. Treatment facilities generally also have very significant operation and maintenance costs.

Nitrates are likely to continue to be a significant issue to communities. The Nebraska Mandates Management Initiative provides a specific case in point. That program is administered by the Department of Environmental Quality and has delivered direct technical assistance on infrastructure problems to a range of communities. Of the 83 communities that had full participation in the program between May 1995 and January 1998, 42 had nitrate concerns listed as an identified issue. Sixteen of the eighty-three communities had received an administrative order for nitrate at some point since 1981 (NDEQ January 1998).

Although the above infrastructure costs are very significant, they were not all paid by the water systems or consumers. Community Development Block Grants and grants and loans from the U.S. Department of Agriculture accounted for much of that cost. An analysis of water rates for some of the affected communities revealed communities which had addressed infrastructure problems due to nitrate had only marginally higher rates versus other communities (see Table 6).

c) <u>Rough Estimated Cost of Improvements for Communities Receiving Administrative Orders</u>

When a project is significantly out of compliance with nitrate standards, the Nebraska Department of Health and Human Services issues an administrative order. Two nitrate MCL violations in a nine-month period will result in issuance of an administrative order. Failure to comply with the terms of the administrative order can result in action to revoke the system's permit to operate. Thirty-six of the small city, village or rural water systems which made improvements since 1981 received nitrate related administrative orders. Another five community water systems not operated by cities, villages or rural water systems also received administrative orders. Between 1991 and 1997 nitrate accounted for 34 of the 69 administrative orders issued for violations of water quality standards or 49%. Since 1981 a total of about 62 Nebraska community water systems serving under 10,000 people have received a total of about 74 administrative orders related to nitrate contamination problems. Forty-one of those systems have subsequently made or are making some type of nitrate related improvement to their system.

Table 6
Average Monthly Water Rates in Small Cities and Villages Which Made Nitrate Related Drinking Water Infrastructure Expenditures Compared to Average in Nebraska Rural Water Association Survey

Metered Wells

	Average
Communities which made nitrate related infrastructure expenditures:	$8.14
Per 1000 Overage Charge:	$0.93
Statewide:	$7.51
Per 1000 Overage Charge:	$0.92

Flat Rate Wells

	Average
Communities which made nitrate related infrastructure expenditures:	$12.54
Statewide:	$10.15

Source: Nebraska Rural Water Association, 1997, 1997 Rate Survey (Metered Water Rates and Flat Water Rates sections) and Health and Human Service System files (average based on per capita basis). Comparison included 31 of the 58 communities which made nitrate related improvements (11 flat rate and 21 unmetered).

Completed improvements accounted for about 51 new wells, 68,111 feet of pipe and 752,000 gallons of storage.

Available data seem to indicate that since 1981 seven Nebraska small cities or villages have built or undertaken nitrate contamination related drinking water projects that have included new water treatment plant facilities. The cost of that infrastructure was about $6,933,512. These seven small cities or villages constitute about 12% of the 59 total communities that have made or are making nitrate contamination related infrastructure improvements. However, they constitute about 28% of all nitrate contamination related drinking water system infrastructure improvement over that period. Treatment facilities also generally have very significant operation and maintenance costs.

Forty-five small city, village and rural water systems accounted for 57 of the 74 administrative orders issued. Other administrative orders went to non-city or village operated systems. Of the forty-one community systems with administrative orders that upgraded their infrastructure, 36 were small city, village and rural water systems. Those accounted for $11,283,298 of the total cost. In comparison, small cities, villages and rural water systems that had not received administrative orders account for $12,941,716 of the total $24,225,014 cost to small city and village systems.

d) Economic Costs to Self Supplied Domestic Users

Public water supply systems are not the only consumers affected by the costs of responding to nitrate related contamination. A Nebraska Department of Health study which sampled 1,808 private domestic wells in 1994–95 found that approximately 19% of the wells sampled were over the federal maximum contaminant level for nitrate nitrogen (CSD/NDOH, 1996). In 1990 domestic water wells provided an estimated 110,754 households (1980 and CSD/NDOH, 1996). NNRC estimates indicate about 21% of Nebraskans were served by self supplied domestic water in 1995. Because the wells selected for the CSD/NDOH study were from residences where occupants were actively engaged in farming and/or occupied at least 6 acres of land, the samples may well not accurately reflect all private wells. It seems possible that wells on smaller nonagricultural plots might either tend to be of more recent vintage or tend to have been subject to a change of ownership that resulted in well improvements. However, they may also be more concentrated and possibly more subject to septic tanks. Private well use is expanding in the rural areas around Lincoln, Omaha and Grand Island.

Whatever conclusions are drawn about the level of health risk the study's monitoring results may pose, it does indicate the potential for nitrate related expenditures by owners of some private domestic wells. If costs of deepening or replacing private domestic wells may be in the $1,500 to $3,000 dollar per well range, the costs of bringing all wells into compliance could be very high even if those wells could be identified. However, the availability of other options such as point of use treatment and concerns about the cost effectiveness given the level of health risk to individuals other than pregnant women and infants are among factors that are likely to be relevant to any response. Increased well depth and grouting are a likely solution to many domestic well problems. Alternatives for self supplied rural domestic water users are discussed elsewhere in this report. No survey was done of how many rural domestic well owners with high nitrates are using point of use systems. They tend to cost in the range of $100 to $400.

The percent of rural domestic water users who test their water and have an idea of nitrate levels is not known. Data from a nine state 1994 survey of 5,520 private well users by the Centers for Disease Control (CDC 1996) show that about 44% of those responding said their well had never been tested for contamination, about 44% said it had and about 11 percent did not know. That study included Nebraska. However, nitrate is among the easier and more common contaminants to test for and Nebraskans awareness of those problems may make testing more common in the state.

As of 1995 there were 59 Nebraska towns which had no public water systems. In addition there are unincorporated developments without public water supplies. The proximity of septic tanks and wells in a concentrated space is of concern in some of these areas. In many cases the older domestic wells may not be as well sited or constructed as a community well would be. At least one small town was installing its first community water system as this report was being written. Some areas with concentrations of residences without a public water supply are potential candidates for adoption of a community water system.

e) Methodology for Developing Cost Estimates

Cost estimates of nitrate related infrastructure expenditures between 1981 and 1997 were developed from a Natural Resources Commission survey of communities and Nebraska Health and Human Services System and Community Development Block Grant data for this study. This data includes estimated final expenditures for projects underway. In addition to that data estimated expenditures approved in project plans for the last two years were used to develop information on how nitrate related expenditures compared to overall water system infrastructure estimated expenditures approved in that two-year period.

Plans and specifications for all major public water supply system construction or alteration must be submitted to the Nebraska Health and Human Services System for review and approval prior to contracting/construction. An initial review fee for those projects is based in part upon the engineer's estimate of the cost of the project. A final review fee is later based on final project costs. Records from the initial reviews were used to develop information on how expenditures estimates approved for nitrate related projects compared to overall public water system infrastructure expenditure estimates approved in the last two years. Similarly those records were used to develop a synopsis of nitrate related small community water system expenditures since 1981.

The challenge in using the project records was twofold: 1) determining which expenditures were nitrate related, and 2) determining the total expenditures on a project. Although not completely successful several methods were used to help determine which projects were nitrate related. Health and Human Service System computer databases were screened to see which community water systems had received administrative orders for nitrate and which had received a nitrate sample reading of above 7 ppm at least one point since 1981. Then Health and Human Service System paper files for the identified community systems were examined for type of project, estimated project cost, and any information on whether the project was nitrate related.

That information did not always reveal costs whether a project was constructed primarily in response to nitrate. Most community water systems identified as having made nitrate related expenditures were cross-checked with community development block grant (CDBG) files to ascertain total project expenditures for those projects funded by CDBG. Finally, mailings were made to all communities identified as having made or possibly having made nitrate related community water system infrastructure expenditures since 1981. Those mailings requested that the water system correct its cost figure if it was substantially incorrect or if the expenditures had not been nitrate related. A copy of the survey form and one of three survey letters are included in the appendix.

In those communities for which there is also a separate record of an NHHS administrative order to deal with nitrate immediately, subsequent projects were deemed nitrate related unless a returned survey declared otherwise. Paradoxically, the communities which undertook infrastructure construction in response to an administrative order were easiest to identify. Communities which responded to nitrate prior to receiving an administrative order were harder to identify.

Current and Future Domestic Water Demand

Current domestic water use provided by public water supply systems, rural water districts, and self-supply private systems has been estimated by the U.S. Geological Survey (USGS) and Nebraska Natural Resources Commission (NNRC, 1998). The future domestic water demand will depend on population change, water rates, climatic conditions, and conservation practices.

CURRENT DOMESTIC WATER USE

Based on USGS/NNRC's 1995 Water Use Study, public-supplied, self-supplied, and total domestic water uses were estimated as 155.41, 41.85, and 197.25 million gallons per day (MGD), respectively. Population served by public water supply systems and self-supplied private systems were estimated as 1,290,700 and 346,000, respectively. There are 23 rural water districts (RWDs) which serve about 22,600 people in Nebraska. Twenty-one percent of the state population was served by private systems in 1995. This is almost the same as the 20 percent estimated by the UNL Conservation and Survey Division (CSD & NDOH, 1996)

FUTURE DOMESTIC WATER DEMAND

In order to project future domestic water demand, some efforts in the previous studies will be reviewed first. Then statewide population and domestic water use trends will be examined. Those trends will also be investigated based on three precipitation zones since climatic conditions strongly influence the amount of domestic water use. Future domestic water demand trend will be projected and discussed.

Previous Studies

In the Nebraska Soil and Water Conservation Commission's (currently NNRC) report on The Framework Study (NSWCC, 1971), the state's total population for 1980, 2000, and 2020 was projected to be 1,610,000; 1,850,000; and 2,150,000. The state's rural population projections for 1980, 2000, and 2020 were 530,000; 475,000; and 450,000. Based on the NNRC's Water Use report (1998), the state's total population and rural population with private water supply in 1995 were 1,637,000 and 346,400, respectively. Therefore, the state's total and rural populations were overestimated in the Framework Study.

It was projected in the Framework Study that per capita water requirements in gallons per day (gpd) for small communities would be 80 to 150 depending on their population sizes and geographical locations. Rural domestic water use rates were projected to be 80 gpcd in eastern Nebraska and 120 gpcd in central and western Nebraska.

Population Trends

Population trends from 1970 to 1990 seem to indicate that many of Nebraska's small communities have been experiencing decreasing population. Population decreases are likely to decrease a community's pumping demands and thus may ease problems in some areas where increased pumping rates result in declines in water quality. However, declining population can also influence a community's ability to pay for infrastructure needed to respond to nitrate problems. Bureau of Census figures indicate that of the 330 Nebraska communities of under 500 population in 1990, about 63% (207) had declined in population. Since 1970 the median community of under 500 experienced a 7% decrease in population. Of the 205 communities above 500 population 52% (106) declined in population over the same period. The median community of over 500 experienced a 1% population decline. Thus of 535 total Nebraska communities 313 declined in population over the 20-year period.

Based on Bureau of Business Research projections the state's population as a whole is expected to increase by 13.6% between 1990 and 2010. The Bureau's map of projected population change from 1990 to 2010 is presented in Figure 4. This increase will not be evenly distributed.[1] The metropolitan counties (those having the largest base population) are expected to have the fastest growth. The increases will be less for large trade center counties and even slower for counties considered small trade counties. Rural counties' populations are expected to decrease by 6.7 percent.

The Bureau of Business Research county level projections can also be examined in light of precipitation zones provided in Figure 5. Zone 1, the easternmost is expected to have an increase in population, Zone 2 that covers a good portion of the middle of the state is borderline. This zone may or may not have a change in population. Zone 3, the westernmost, is predicted to have a decrease in population (Figure 5 and Table 7). Declining population could affect ability to pay in some communities which make infrastructure improvements in response to nitrate.

Domestic Water Use Trends

The U.S. Geological Survey has published every five years since 1950 estimated water use in all fifty states. Since 1985, total domestic, public supplied domestic and private (rural) supplied domestic water use rates in gallons per capita per day have been estimated for each of Nebraska's 93 counties. Total domestic, public supplied domestic and private supplied domestic rates were plotted in Figures 6, 7, and 8, respectively, for years 1990 and 1995. The three zones noted in each plot are the three precipitation zones previously noted.

[1] The remaining analysis is based on simple averages of the projected county values.

Figure 4

Projected Population Growth by County, 1990 to 2010

[Increases or Decreases (–) in Percent]

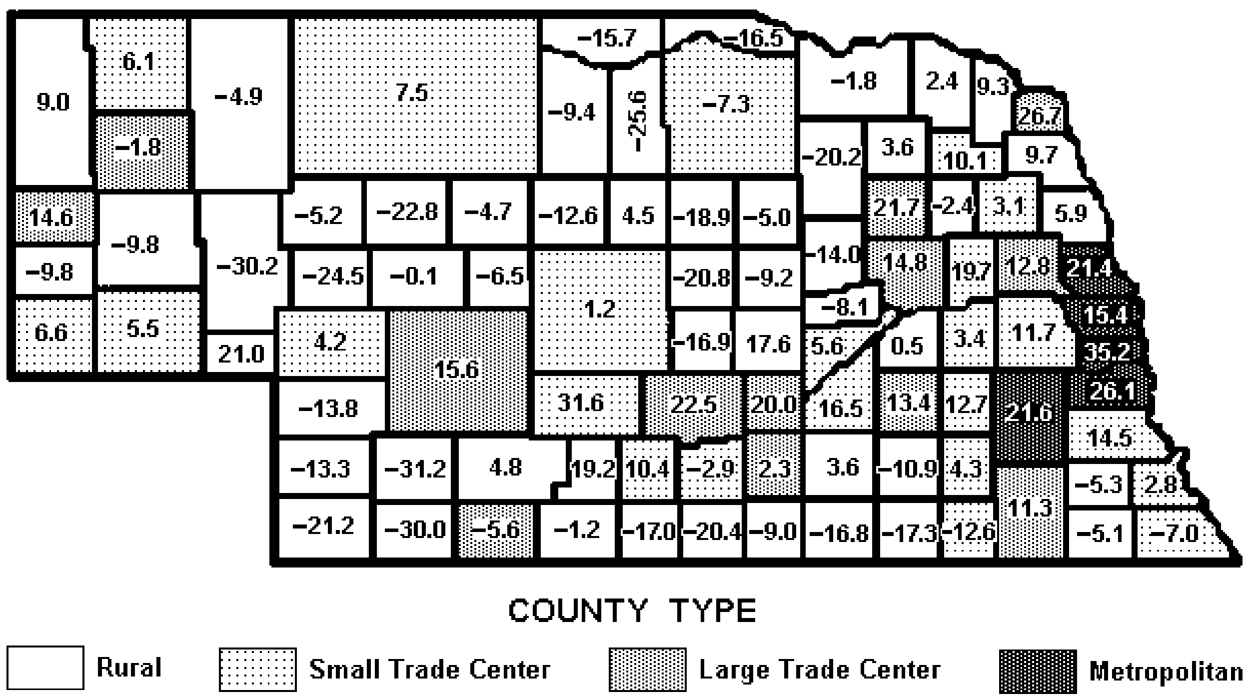


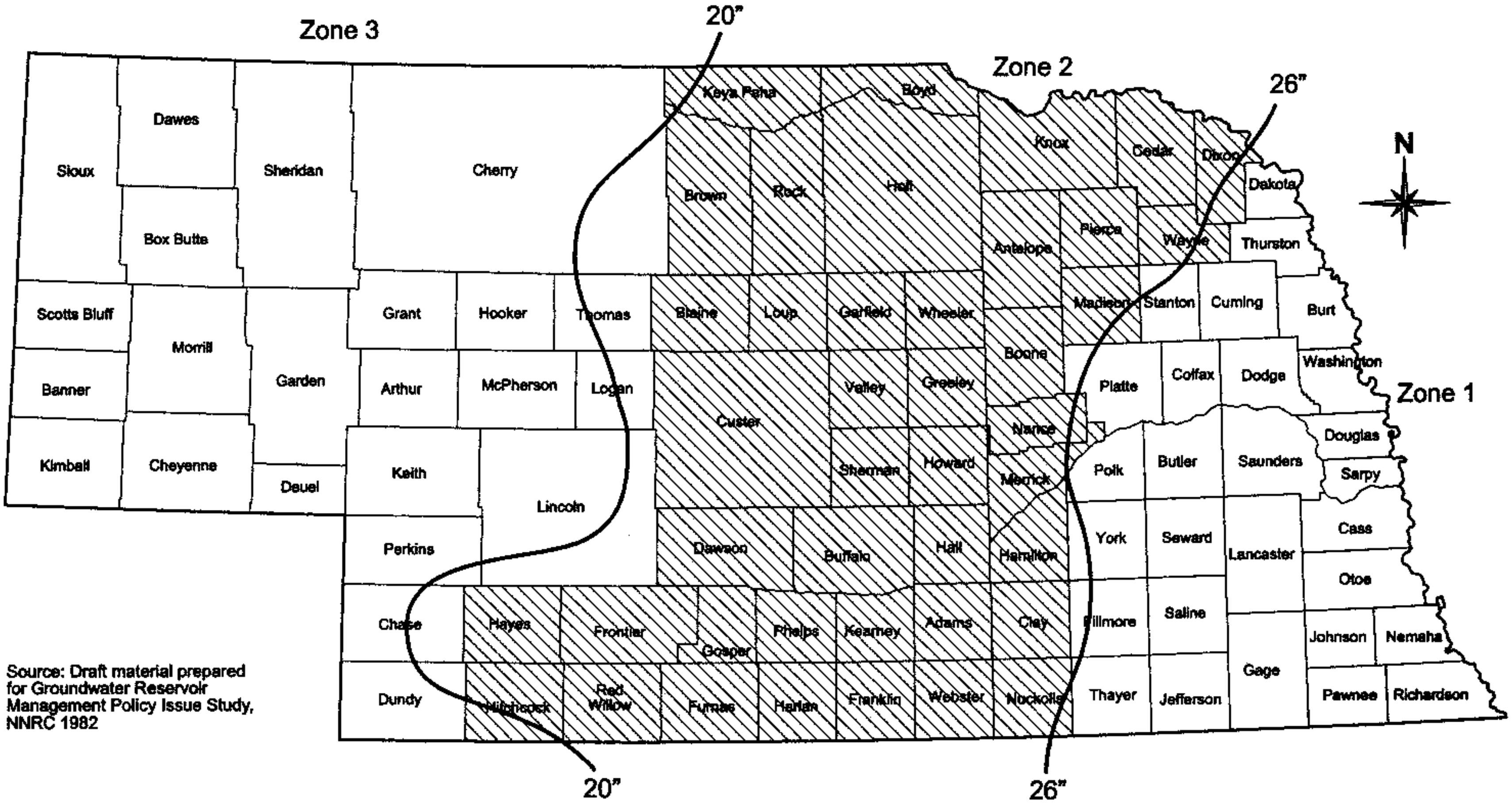
Table 7.—Projected Percent Change in Population 1990-2010
(simple average of county level % population change not weighted by population)

County Type	Precipitation Zone 1	Precipitation Zone 2	Precipitation Zone 3	State
Metro	24.40	N/A	N/A	20.30 (6 counties)
Large Trade Center	13.67	12.18	9.47	14.2 (12 counties)
Small Trade Center	5.26	8.15	5.98	8.00 (23 counties)
Rural	-1.51	-5.62	-9.12	-6.7 (52 counties)
Total	8.09	-0.87	-3.41	13.6 (93 counties)

County Types – Definitions
Metro – County within a metropolitan statistical area (MSA).
Large Trade Center – County outside an MSA, population of largest town is at least 7,500 persons.
Small Trade Center – County outside an MSA, population of largest town ranges from 2,500 to 7,499 persons.
Rural – County of any size with no single community larger than 2,499 persons.

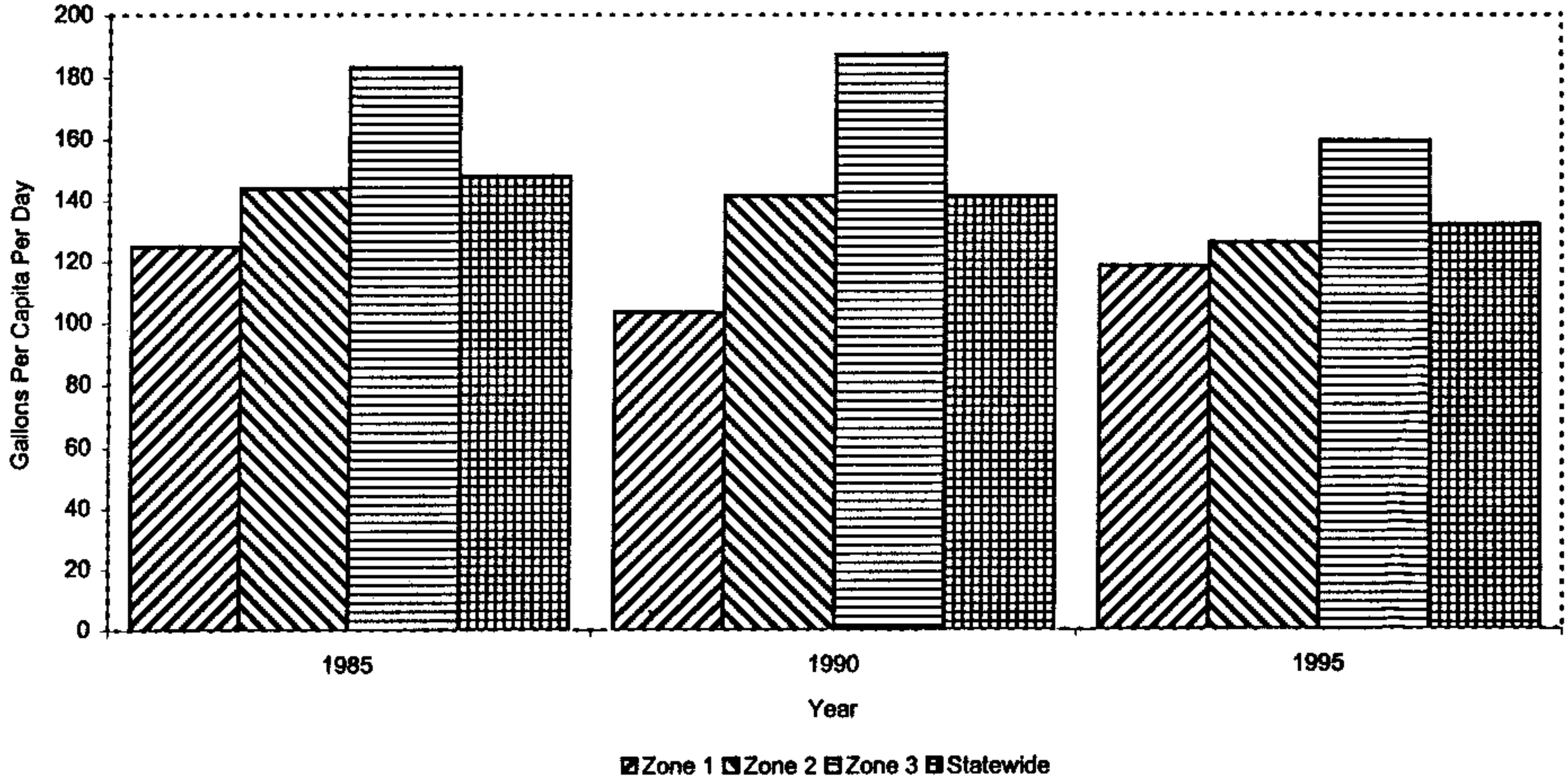
Sources: Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Population Projections 1990 to 2010
Nebraska Natural Resources Commission precipitation zone map (unpublished material generated for Policy Issue Study on Groundwater Reservoir Management

Figure 5
Precipitation Zones in Nebraska



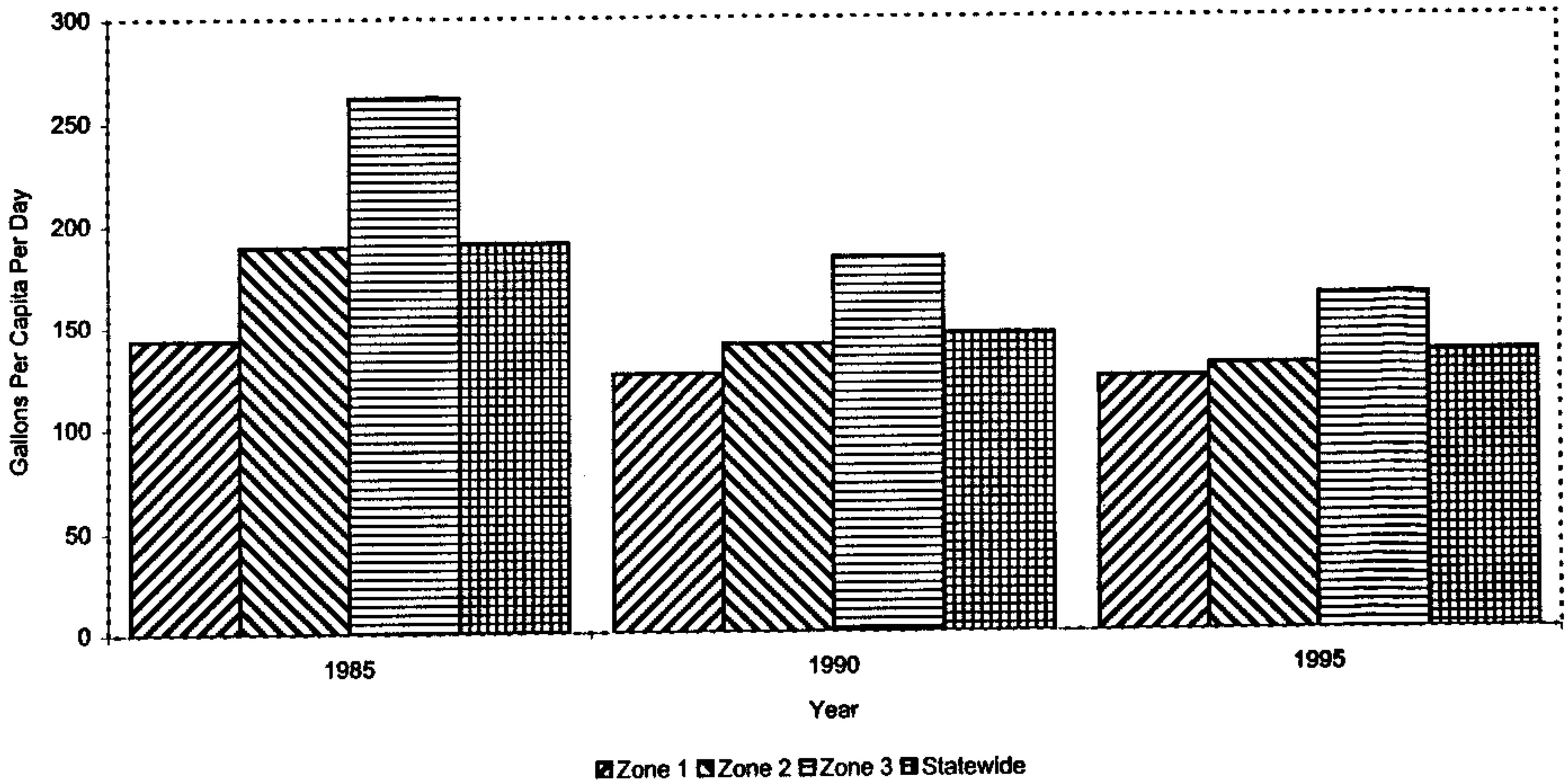
Source: Draft material prepared for Groundwater Reservoir Management Policy Issue Study, NNRC 1982

Figure 6. Total Domestic Water Use Rate



Sources: Estimated Use of Water In Nebraska 1985, by Eugene K. Steele, Jr., USGS Published in Cooperation with UNL Conservation and Survey Division, Nebraska Water Survey Paper #64
Estimated Water Use in Nebraska, 1990, Nebraska Natural Resources Commission, December, 1994. Published in coooperation with the US Geological Survey
Estimated Water Use in Nebraska, 1995, Nebraska Natural Resources Commission, April 1998. Published in cooperation with the US Geological Survey

Figure 7. Public Supplied Domestic Water Use Rate

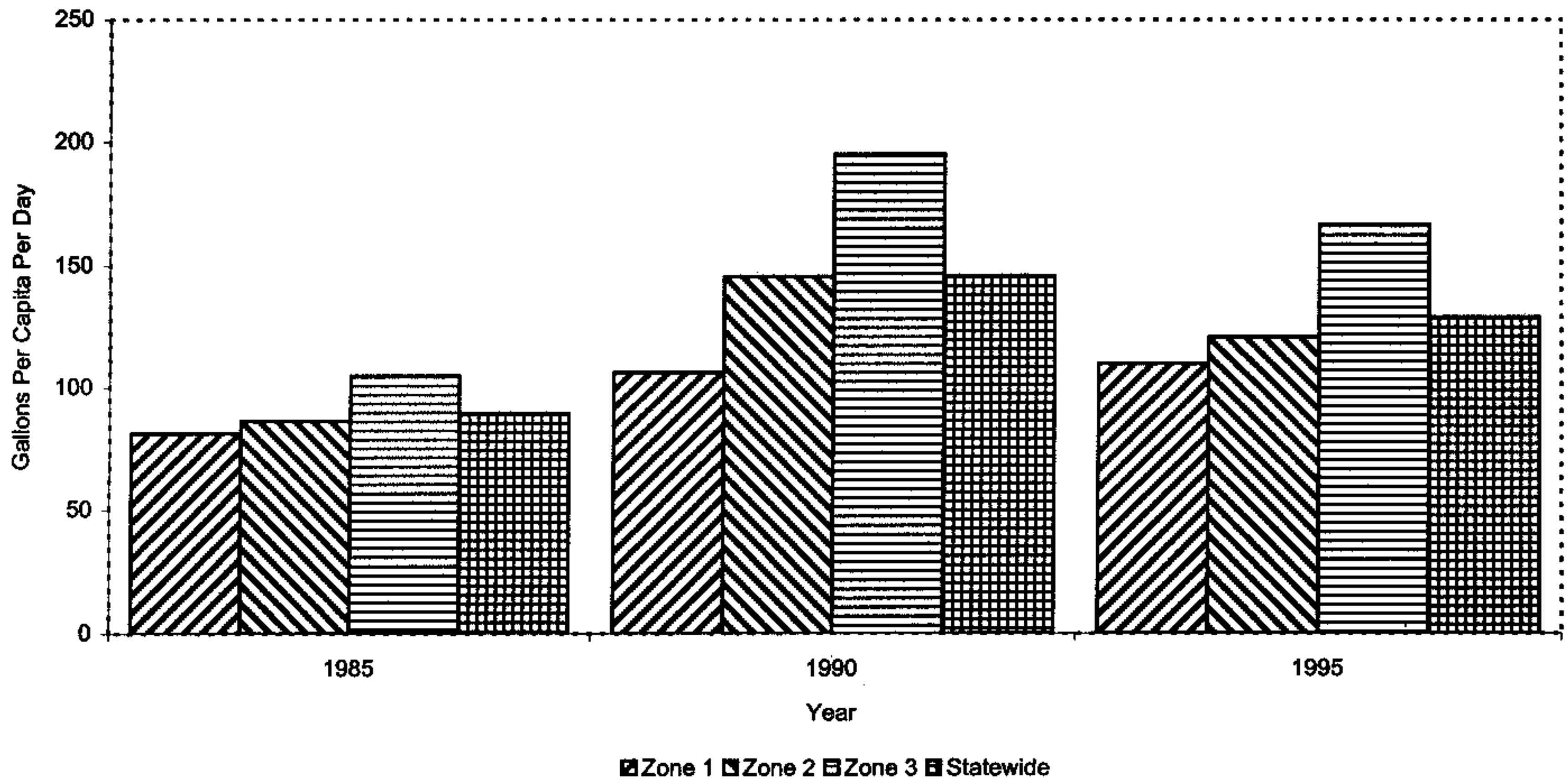


Sources: Estimated Use of Water in Nebraska 1985, by Eugene K. Steele, Jr., USGS Published in Cooperation with UNL Conservation and Survey Division Nebraska Water Survey Paper #64

Estimated Water Use in Nebraska, 1990, Nebraska Natural Resources Commission, December, 1994. Published in coooperation with the US Geological Survey

Estimated Water Use in Nebraska, 1995, Nebraska Natural Resources Commission, April 1998. Published in cooperation with the US Geological Survey

Figure 8. Privately Supplied Domestic Water Use Rate



Sources: Estimated Use of Water in Nebraska 1985, by Eugene K. Steele, Jr., USGS Published in Cooperation with UNL Conservation and Survey Division, Nebraska Water Survey Paper #64
Estimated Water Use in Nebraska, 1990, Nebraska Natural Resources Commission, December, 1994. Published in coooperation with the US Geological Survey
Estimated Water Use in Nebraska, 1995, Nebraska Natural Resources Commission, April 1998. Published in cooperation with the US Geological Survey

All three plots reveal that rainfall influences domestic water use. The rates increase across Nebraska from east to west as the precipitation also decreases from east to west. Dry summer conditions in western Nebraska cause homeowners to water their lawns with tapwater from their domestic water system. Trends in domestic water use rates were not calculated. While records are available for previous periods, differing methods of calculation and differing precipitation amounts make comparisons questionable.

Per Capita Use Factors

Changes in demand for an individual system are a function of both population and per capita use. Per capita use can in turn be influenced by a myriad of factors. Some of the more important ones include changes in household size, changes in conservation measures, changes in industrial/commercial use, changes in system efficiency, and changes in cost of water to the consumer.

The number of households in Nebraska are growing at a faster rate than total population. Between 1980 and 1990 Nebraska population grew 5.0% while the number of households grew about 10.4%. There is a tendency for a somewhat higher per capita water use in a small household than in a large household. Therefore, the trend, if it were to continue may increase per capita water use rates to some degree. If those figures were to be used, an effort would need to be made to determine trends in household size specifically for small communities and rural areas.

Increased awareness and adoption of conservation measures may also influence domestic water demand to some degree in future years and may also provide significant savings to commercial enterprises. In an individual small community an industrial water user can play a significant role in total water use and adding or losing such a user or conservation measures they adopt can significantly affect total per capita use figures.

Changes in system efficiency may also play a role in per capita use. Some aging systems may have significant leakage which may be controlled when new mains are installed. Many of Nebraska’s small communities do not meter individual water use. Should metering begin in some of those communities, it might have the affect of some decrease in demand.

In addition to the above information, estimated domestic or municipal water use by county or basin is available from the USGS water use reports issued once every five years. The 1985, 1990 and 1995 volumes contain estimated per capita water use by county (NNRC 1994 and 1998) (Steele 1988).

Overall, the available information was not deemed sufficient to make per capita water use projections for this study.

Projected Future Domestic Water Demand

All other things held equal, an increase in population would result in an increase in demand for water for domestic use. One can conclude that the metropolitan counties, Large Trade Center counties and Small Trade Center counties will experience an increase in population and thus an increase in demand for water by about 20, 14, and 8 percent, respectively. That calculation is based upon the average percent change by county and is not weighted by population. A majority of the rural counties will lose population and thus reduce the demand for domestic water by 7 percent in those areas.

OTHER SOCIAL - ECONOMIC FACTORS

The social and economic factors most closely tied to high nitrate levels are population, land use, and the general economic health of the area affected. These three factors either influence the level of nitrates in the ground water or are impacted by the level of nitrates or, in some cases, both.

Population

Demographic factors can affect rural/small community water supplies issues through impacts on water quality, the need for additional water supply infrastructure and the ability to pay for new or existing infrastructure.

Other things being equal, more population can result in more urban land uses, more opportunity for point source spills and more demand for agricultural production or other activities taking place on the land. Other factors are not always equal. Better land management techniques and more careful use of potential pollutants are among the factors that may stem or reverse the potential negative effects of increased population levels.

Increased population can also result in increased demand for community water supplies. A source of supply or a level of infrastructure that was adequate for one size of population may be inadequate for a different level. The increased demand may result in a need to overuse a well with poor quality water. Conversely a decrease in population may help avoid the problem.

A decrease in population, especially a decrease in working age population, may accentuate any problems a community has in paying for new or existing water supply infrastructure.

Population in the State of Nebraska rose from 1,325,510 in 1950 to an estimated 1,652,093 in July 1996; an increase of 326,583 people, almost 25%. However, that increase has not been distributed evenly. The Omaha and Lincoln metropolitan areas alone grew by 375,121 people over that period. Thus the remainder of the state, taken as a whole, lost population.

Detailed Study Area Information

The population estimates for the six counties making up the Detailed Study Area were as follows: Buffalo 37,560, Clay 7,113, Hall 49,076, Hamilton 8,854, Merrick 8,034, and York 14,411.

The breakdown by size of community for these same six counties is shown in Table 8. Only three of the counties have communities larger than 5,000. The other three have only communities of less than 5,000 and rural areas. For the detailed study area counties, about 57% of the population lives in communities of greater than 5,000 persons, about 21% live in communities of less than 5,000 and about 21% live in rural areas. The group having the oldest median age was Communities less than 5000, except for Hall County, where the rural population was the oldest group.

The Bureau of Business Research (BBR) has projected population changes for the state and individual counties. Some of that data is presented in Table 9. From 1990 to 2000, the population of the state is expected to increase 13.6 %. Four of the detailed study area counties experience rapid growth: York 13.4%, Hamilton 16.5%, Hall 20.0%, and Buffalo 22.5%. Clay and Merrick counties are expected to have slower but still increasing populations, 3.6% and 5.6% respectively.

The BBR further breaks down the population predictions to focus on the working age population (ages 16 to 65). Overall, 57 of the 93 counties in the state should expect increases in the size of the working age population. All counties in the detailed study area will increase with the larger trade counties (Buffalo, Hall and York) having greater increases than the smaller trade counties (Hamilton and Merrick) or rural Clay county. The only counties in the state expected to have decreases in the working age population are several of the rural counties with total populations of 5000 or less.

Table 8
POPULATION AND MEDIAN AGE
BY SIZE OR TYPE OF COMMUNITY

	Communities >5,000		Communities <5,000		Rural	
County	*Population*	*Median Age*	*Population*	*Median Age*	*Population*	*Median Age*
Buffalo	24,396	25.8	5,589	36.0	7,462	32.8
Clay	----	----	4,922	40.1	2,201	31.1
Hall	39,386	33.0	3,165	33.9	6,374	34.1
Hamilton	----	----	5,364	37.2	3,498	32.1
Merrick	----	----	4,917	38.0	3,125	33.4
York	7,884	34.9	2,487	40.9	4,057	30.9
Total	71,666		26,444		26,717	
Average		30.8		33.7		32.7

Source: Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Profiles, BBR Internet Website

Table 9
COUNTY AND STATE POPULATION
ESTIMATES AND PROJECTIONS

County	1990 Pop. Estimate	1995 Pop. Estimate	2010 Pop. Projection	Population % Change 1990-2010	Working Age Population* % Change 1990 to 2010
Buffalo	37,560	39,516	46,009	22.5	30.7
Clay	7,113	7,132	7,369	3.6	8.9
Hall	49,076	51,178	58,897	20.0	29.7
Hamilton	8,854	9,305	10,316	16.5	24.3
Merrick	8,034	8,156	8,483	5.6	9.7
York	14,411	14,624	16,337	13.4	25.2
State	1,580,670	1,637,112	1,795,158	13.6	

Source: Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Population Projections 1990 to 2010, April 1997
* Ages 16 to 65 years.

The towns and cities located in the detailed study area are listed in Table 10 along with their estimated populations from 1990 to 1994. In Hall and Hamilton counties all the cities and towns increased in size. In Merrick County only the largest city increased. York County had towns that increased in population and some that lost population. Buffalo County's largest town increased with the rest having no real pattern. As a rule, those places near 1000 population increased or held steady and the smaller places decreased. Clay County did the worst. Two towns of less than 300 people had major decreases with the rest holding even or slightly increasing.

Land Use for the Detailed Study Area and the State

The towns and cities mentioned in Table 10 actually take up only a small portion of the total acres of the detailed study area counties. The majority of the land in the detailed study area is used for farming. In 1992 the total acres harvested of five major crops (corn, soybeans, grain sorghum, hay, and wheat) was 92.5 % of the total acreage of those six counties. 72.3% of the total acres were irrigated. Over time, the mix of crops has changed with corn replacing some of the grain sorghum, hay and wheat acres.

Table 10
Population Estimates 1990 to 1994 for Cities and Towns in
Counties in the Detailed Study Area

	1990	1991	1992	1993	1994	1990-94 % Change
Buffalo County						
Amherst village	231	207	220	214	216	-6.49
Elm Creek village	852	900	885	872	901	5.75
Gibbon city	1525	1545	1518	1530	1506	-1.25
Kearney city	24396	24868	25273	25843	26216	7.46
Miller village	130	135	129	122	123	-5.38
Pleasanton village	372	362	349	363	362	-2.69
Ravenna city	1317	1337	1398	1396	1414	7.37
Riverdale village	208	206	214	207	208	0.00
Shelton village	954	986	944	988	951	-0.31
Clay County						
Clay Center city	825	838	849	851	856	3.76
Deweese village	74	79	85	77	80	8.11
Edgar city	600	597	600	599	603	0.50
Fairfield city	458	431	439	459	473	3.28
Glenvil village	304	287	296	294	270	-11.18
Harvard city	976	988	1003	1006	1023	4.82
Ong village	69	71	70	61	57	-17.39
Saronville village	38	38	38	38	39	2.63
Sutton city	1353	1350	1361	1338	1382	2.14
Trumbull village (pt.)	225	215	208	210	223	-0.89
Hall County						
Alda village	540	518	536	523	554	2.59
Cairo village	733	732	731	738	750	2.32
Doniphan village	736	760	778	820	863	17.26
Grand Island city	39487	39937	40249	40809	41147	4.20
Wood River city	1156	1152	1171	1264	1268	9.69
Hamilton County						
Aurora city	3810	3828	3830	3859	3869	1.55
Giltner village	367	372	374	380	383	4.36
Hampton village	432	435	435	439	441	2.08
Hordville village	164	166	167	169	171	4.27
Marquette village	281	286	289	294	298	6.05
Phillips village	316	320	323	328	331	4.75
Stockham village	64	65	66	68	69	7.81
Merrick County						
Central City city	2868	2903	2971	3026	3035	5.82
Chapman village	292	291	294	300	290	-.68
Clarks village	379	372	357	351	337	-11.08

Palmer village	434	431	434	430	427	-1.61
Silver Creek village	437	434	439	435	433	-0.92
York County						
Benedict village	230	229	231	231	230	0.00
Bradshaw village	330	329	331	331	331	0.30
Gresham village	253	252	252	251	250	-1.19
Henderson city	999	983	974	962	947	-5.21
Lushton village	28	27	27	27	26	-7.14
McCool Junction village	372	373	377	379	380	2.15
Thayer village	64	64	65	65	66	3.13
Waco village	211	210	211	210	209	-0.95
York city	7940	7929	7999	8020	8020	1.01
Source: Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Profiles, BBR Internet Website						

This is in stark contrast to the data for the state. Only 32.9% of the state were harvested acres in 1992, and only 12.9% of the total acreage were irrigated. The state has also not experienced the shift in cropping pattern that the detailed study area did. The environmental portion of this task report provides for the data on land use in the state and detailed study area.

Economic Well Being

Three indicators were examined to evaluate the economic well being of the detailed study area counties relative to the state as a whole. These were based on 1989 information and are included as Table 11.

Table 11
MEASURES OF ECONOMIC WELLBEING OF
DETAILED STUDY AREA COUNTIES AND STATE

County	% of Persons Below Poverty Level[1]	Per Capita Personal Income[2]	Median Family Income[3]
Buffalo	14%	$19,152	$38,800
Clay	11%	19,286	34,900
Hall	10.7%	19,953	39,600
Hamilton	8.8%	19,220	38,000
Merrick	11.3%	17,965	33,700
York	6.6%	21,487	41,300
State	11.1%	21,447	42,262

[1] 1989 data.
[2] 1985 data.
[3] FY 1995, for four-person family.

For the state only 11.1% of the persons are considered to be living below the poverty level. In the detailed study area, Buffalo County has 14% and Merrick had 11.3% below poverty but the remaining counties had less than the state level (Clay 11%, Hall 10.7%, Hamilton 8.8%, and York 6.6%).

The average per capita income for the state was $21,447. Only York County was greater than this figure, $21,487. The other five counties were considerably lower: Buffalo $19,152, Clay $19,286, Hall $19,953, Hamilton $19,220, and Merrick $17,965.

Based on the median family income for a family of four, all of the DSA counties were lower than the state average $42,262.

Capacity to Pay

A number of studies have been made of rural communities and their capacities to pay for water and other public works improvements. These studies primarily rank the communities based on income and wealth measured by various means. Data assembled for the Nebraska Mandates Management Initiative focuses on median household income, per capita income and valuation per capita. Supalla and Ahmad developed a financial capacity index for individual communities that was defined in terms of the percent of households in each of 10 income classes and the average valuation per household in the community. These two factors were then weighted in the estimates. Their estimates of financial capacity for 440 Nebraska communities with populations of 5,000 or less ranged from 9 to 110 dollars per month.

Both studies result in rank order or an estimate of relative abilities based on stated criteria. This value shows only how each community stands relative to other communities. These studies do not take into account current financial obligations, expected population changes, income source types (fixed or variable incomes) or other public works problems.

Supalla and Ahmad also bring up the question of who pays for public improvements. How much should the direct beneficiaries pay and how much should the taxpayers pay?

Social Effects - Fear, Inconvenience, And Health Risks

FEAR

Fear is probably the first social effect experienced upon discovery of high nitrates in the water in an area. Drinking water is often taken for granted until it is not available. Unless a person is experienced in natural resources or water quality fields their initial knowledge is probably limited about nitrates and their effects. In this case a little information may be dangerous and may cause unneeded anxiety about potential health problems and or how to react.

INCONVENIENCE

The inconvenience of finding an alternative source of water when nitrate levels get too high is another major social effect. Nebraska law requires community water systems to provide bottled water for infants less than 6 months of age and for pregnant women. This is a cost to the water system not to the individual. Others may also wish to use bottled water at their own expense. Residences with their own wells may opt to buy bottled water even though not required by law, at least until they evaluate their options. No matter who pays for it, at approximately 8 pounds per gallon, obtaining and using bottled water is more inconvenient than turning on a faucet and running a glass full.

HEALTH RISKS

High nitrate levels are related to several health risks. The most common is Methemoglobinemia or "blue baby syndrome". This affects infants under six months of age and can be toxic. It literally is a form of slow suffocation for the infant. There is also a potential for prenatal methemoglobinemia or birth defects associated with high nitrate levels. Pregnant women should avoid drinking water with nitrate levels higher than 10 milligrams per liter.

There have been some indications of a potential link between high nitrates in drinking water and gastrointestinal cancer. This link is controversial at this time.

Livestock may also be susceptible to nitrate problems, especially cattle. Signs of nitrate poisoning are lowered milk production and aborted calves. In general livestock can tolerate much higher nitrate levels than humans. It is more common for nitrate poisoning to be a result of feeds fed to the cattle than of the water they drink.

Economic Impacts

High nitrates in the drinking water will have economic impacts on every person in the area in one way or another. Individuals and households may experience the economic impacts in a number of ways. Those who purchase their own bottled water, at the rate of 1 gallon per person will pay slightly more than $8.00 per person a month to have safe water. (This estimate is based on 1 gallon per day per person at 27 cents per gallon to refill their own jugs at a discount grocery store.) If they are served by a Community Water System they may still expect a cost increase coming as a potential rate increase and or a tax increase to repay loans or retire bonds that the municipality may have needed to finance a water system upgrade.

A community will see the impacts as the cost of supplying bottled water in the short run, and then in the long term the costs to upgrade their water system, i.e., a new well, extra storage, or water treatment equipment. There will also be an increase in the cost of water testing required. A portion of these costs can be passed on immediately to the water user through a rate increase. However if the outlay is substantial, the community may find it necessary to borrow money or to let a bond. Then over a longer period of time increased water rates or increased local tax rates can repay this money.

Agricultural producers can face similar costs as previously described for individuals and households, but they may be impacted in other ways as well. Best management practices for water quality can have costs to producers as well as water quality benefits. If improved water quality were the only objective, land use in some instances could potentially change from irrigated farming to dryland, and corn production might diminish with an increase in alfalfa or soybeans, or in extreme cases cropland might be converted to pasture or range. A positive impact that farmers have experienced is when they can take advantage of nitrates in the irrigation water and reduce the amount of N they apply to their crops. By taking advantage of the nitrogen available to the plants from the water, they can reduce their costs of production. Although high levels of irrigation are often a suspect in nonpoint source water quality problems, they may improve water quality in some of these instances.

Many will suffer the economic consequences of responding to nitrate problems. Home owners may find that private well problems affect the value of their home or result in costs to drill a new well, treat, or find a new source. Communities forced by law to upgrade their water systems may have higher water rates. Federal government grant and loan programs may subsidize those communities but result in some increase in taxes at the national level.

LAND USE/ENVIRONMENTAL FACTORS

Introduction

The purpose of this portion of the task force report is to provide an outline and analysis of the land use and environmental setting factors relevant to rural and small community water supply issues. The analysis will focus particularly on potential nitrate-nitrogen impacts to those supplies. It will examine those issues both in the context of the state and of the six county detailed study area of Hall, Hamilton, York and parts of Merrick, Buffalo and Clay counties.

Relevance of Land Use/Environmental Setting

Land use/environmental setting factors are important because they can affect the amount of nitrate-nitrogen reaching the water supply. The human body converts consumed nitrate-nitrogen to nitrites. High levels of nitrite can cause methemoglobinemia (blue-baby syndrome) in infants under six months of age, may increase cancer risk in the overall population, and can sometimes cause livestock health problems. The U.S. Environmental Protection Agency has set a maximum contaminant level and a health advisory level for nitrate-nitrogen of 10 parts per million. Readings above that level make a public water system subject to enforcement actions by the Nebraska Health and Human Services System. Private wells are not required to test or meet that standard.

In “Domestic Well Water Quality in Rural Nebraska” (a study by the UNL Conservation and Survey Division and the Nebraska Department of Health) researchers indicated that: “The variability of well water quality between regions is a function of well characteristics, distances to potential contamination sources, and hydrogeologic and site characteristics. These latter characteristics include: (1) on-site agricultural chemical use, which is related to land use; (2) distribution and occurrence of groundwater, which control the depth of the well; and (3) soil and landscape characteristics, which influence not only land use, but the movement of water and its associated contaminants into the groundwater system.” That study also cites a number of potential sources of nitrate in groundwater, including fertilizer, septic systems, animal waste, waste lagoon sludge, and soil mineralization. Figures are available for nitrogen in fertilizer sold as well as for estimated nitrogen generated by livestock. However, determining how much of that nitrogen leaches is a difficult matter. Barnyards are also sometimes cited as a source.

A number of site, hydrogeologic and distance factors are related to natural conditions and land use. This section will examine how land use/human use and natural conditions vary in both the detailed study area and the state in general. It will also examine land use trends. The section will first examine land use/human use factors related to rural small community water supplies including: changes in cropping patterns, changes in the amount of irrigated land, fertilizer use, livestock numbers, changing well numbers, water use and contamination in the vadose zone. It will then examine a variety of natural factors, including: topography, climate, soils, vulnerability to contamination, natural vegetation and fish and wildlife. Relevant material on water supply/quality, geologic conditions and agricultural best management practices is not included, since those items are to be addressed by the Bureau of Reclamation. Some other relevant material, such as septic tank and waste lagoon locations, is not included at this time.

LAND USE RELATED FACTORS

SUMMARY — STATE LEVEL LAND USE RELATED DATA

Land use related factors potentially relevant to rural/small community water supply and nitrate-nitrogen levels in Nebraska include: changes in cropping patterns, changes in the amount of irrigated land, other land use changes, fertilizer use, irrigation well registrations and water use data, livestock numbers and changing use of agricultural best management practices and population levels.

Irrigation can often increase the potential for leaching of nitrogen. The amount of irrigated land on farms in Nebraska has risen 190% since 1964 and in 1992 comprised 12.9% of the total land in Nebraska. This was up from just 4.1% of land in 1959 according to Bureau of Census figures. Nebraska currently ranks second in the nation in the number of irrigated acres. Corn accounted for almost 45% of harvested acreage in 1992, up from just over 37% in 1959. Soybean acreage grew from less than 1% of harvested acreage in 1959 to more than 14% in 1992 according to Census of Agriculture data. Harvested cropland in 1992 comprised just under 1/3 of the state’s total land. Between 1962 and 1994 the tonnage of commercial fertilizer sold in Nebraska rose 491%. Between 1950 and 1996 the inventory of hogs and pigs on farms in the state rose over 64% and the number of cattle on farms rose over 65%. However, cattle numbers are about the same as they were in 1970 and hog and pig numbers in 1996 were slightly lower then in 1980.

Exner and Spalding (1990) provided material indicating that an estimated 755,000 tons of nitrogen were applied to Nebraska farmland in 1987 while an estimated 235,000 tons of nitrogen were produced in cattle and hog manure. However, no figures were available on how much of the manure was applied to the land.

Cumulative registered irrigation well numbers in Nebraska rose from 4,068 in 1956 to 29,167 in 1966 to 84,501 in 1996. In 1995 irrigation accounted for over 93% of Nebraska groundwater use.

Standing alone data on increased irrigation, increased fertilizer use and increases in human and some livestock numbers would seem to indicate the potential for some increase in potential threats to water supply. However, these data must be balanced against increased use of agricultural best management practices, better waste management practices and better well construction techniques. Irrigation water management and fertilizer use practices are an area being addressed in the groundwater management plans of most of Nebraska's natural resources districts. In the 1990's Nebraska has updated its solid waste management policies and substantially reduced the number of landfills in the state

SUMMARY OF DETAILED STUDY AREA LAND USE RELATED DATA

The amount of irrigated land in the six counties that encompass the detailed study area has more than doubled since 1964. By 1992 irrigated land comprised 72% of the total land in the six counties. Almost 2/3 of the total acreage of the detailed study area was planted to corn in 1992, up from less than half in 1959. Corn accounted for nearly 72% of harvested acreage. Soybeans expanded from half a percent in 1957 to 9½% of total acreage in 1992. Over 92% of total land in the six counties was in cropland. Tonnage of commercial fertilizer sold in the six counties nearly quadrupled between 1962 and 1994 with a 1994 figure at 381% of the 1962 data. However, tonnage sold statewide in the period rose even more quickly. Between 1964 and 1992 the number of hogs and pigs on farms in the six counties more than doubled. However, the total number of cattle on farms in the area rose only slightly.

Cumulative registered irrigation well numbers in the six counties encompassing the study area have risen from 1,037 in 1956 to 10,173 in 1966 to 20,904 in 1996. Water use estimates for domestic and irrigation use are available only since 1985. Estimated domestic water use in the six counties rose about 10% between the two years 1985 and 1995. However, comparisons between single years with differing climatic factors can be misleading and the different methods of estimation mean that data is not strictly comparable.

Portions of the detailed study area appear to include some of the state's higher levels of nitrate-nitrogen in groundwater, although trend data is limited (see Bureau work elements). Furthermore, studies by the UNL Water Center appear to show that nitrate-nitrogen in a portion of one of the counties in the detailed study area is moving deeper into the vadose zone (the unsaturated area between the surface of the land and the regional water table) through time. Water samples from test plots in Clay County (1985) had elevated nitrate levels that peaked at a level of 9 meters (about 30 feet). In samples taken 5 years later (1990), the nitrate-nitrogen peaks appear to have moved downgradient to a depth of about 12.5 meters (about 41 feet). However, differing human and natural factors may result in widely differing conditions in the vadose zone.

STATE LEVEL LAND USE/CROPPING/IRRIGATED LAND

Figure 9 presents a land use map of Nebraska. Table 12 and Figure 10 present statewide landuse data in tabular and graphical form. U.S. Census of Agriculture figures were used to derive additional information on cropland acreages and irrigated acreages in Table 13.

Detailed Study Area Land Use/Cropping and Irrigated Land

Table 14 provides the percentage of total acres and the percentage of harvested acres in the six counties that were in various crops or were irrigated in the years 1959, 1974, 1987 and 1992. Figure 11 presents historical irrigated acreage for the state and detailed study area in geographical form. According to those figures extrapolated from the U.S. Census of Agriculture the six counties in the detailed study area were among the most heavily irrigated in the state in 1992, with over 72% of the total acreage of the counties in irrigated land on farms. That compares with just under 13% of Nebraska's total area in being on irrigated land in farms at that time. In 1959 only 34.8% of the land in the six counties had been irrigated.

In 1992 land in corn accounted for almost 2/3 of the land use in the six-county region and for almost 72% of the harvested acreage. In 1959, land in corn accounted for only 46.7% of total acreage and half of harvested acreage. The other crop that accounted for a growing proportion of land use was soybeans, which grew from ½% of total acreage in 1959 to 9½% in 1992. Fertilizers are not generally applied to soybeans.

In 1983/84 land use data was compiled for the six county area as part of the Nebraska Resources Census. Total combined land use for the area at that time is provided in Table 15. A map detailing the land use at that time is provided in Figure 12.

FERTILIZER SOLD

Tonnage of fertilizer used is sometimes one of the factors that may help indicate potential for nonpoint contamination. Table 16 provides annual information of fertilizer tonnage sold in Nebraska since 1960 and Figure 13 presents that data in graphical form. The data indicate that 1994 fertilizer tonnage sold statewide was about 491% of 1962 levels. This reflected major

Figure 9
Nebraska Landuse Map

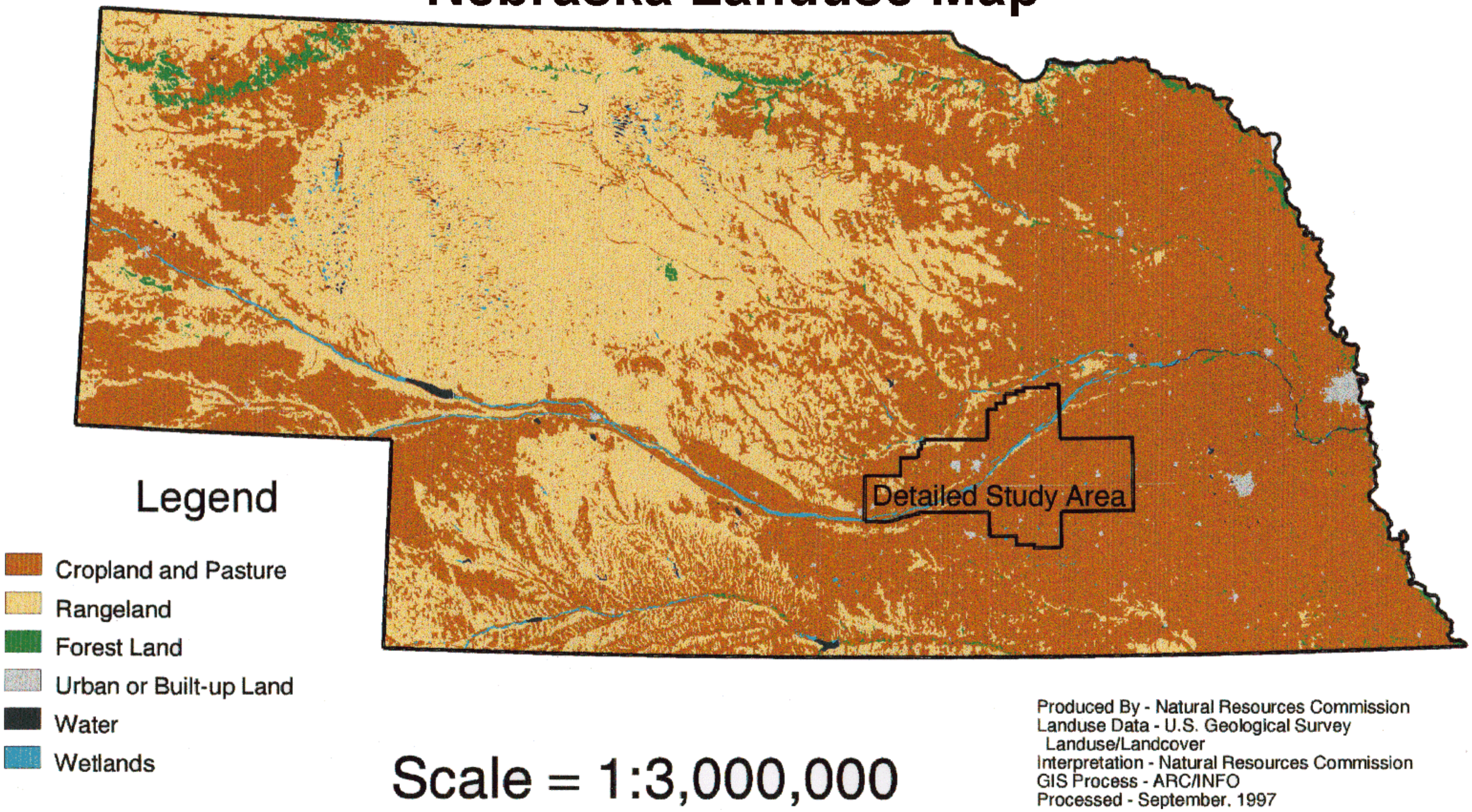
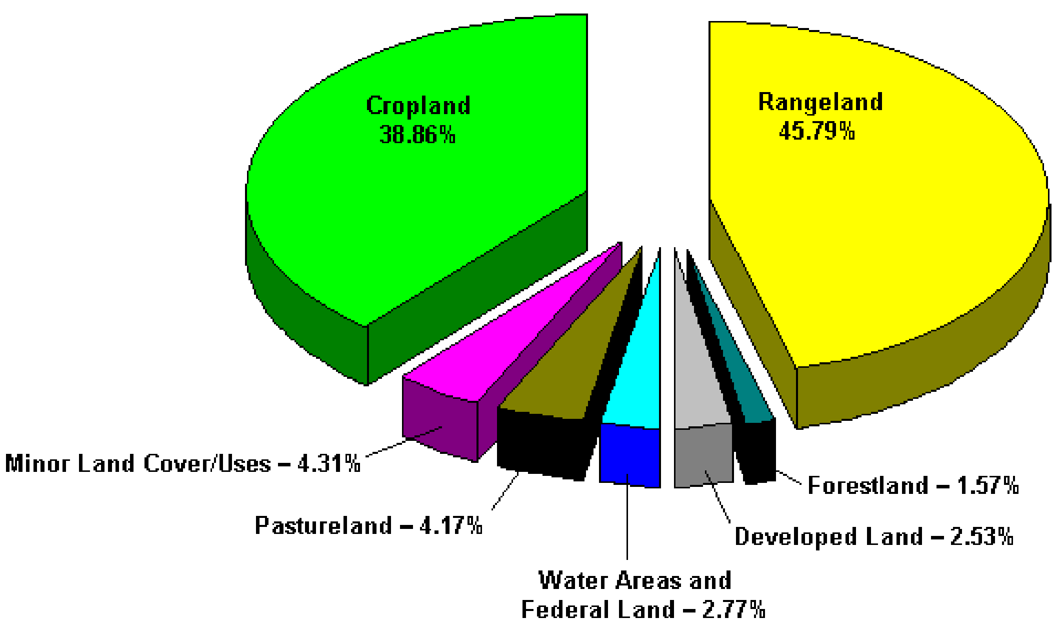


Table 12 - 1982 and 1992 Nebraska Land Use

	1982 % of Total Acres	1992 % of Total Acres
Cropland	40.96	38.86
Rangeland	46.76	45.79
Pastureland	4.30	4.17
Forestland	1.48	1.57
Developed Land	2.45	2.53
Minor Land Cover/Uses	1.49	4.31
Water Areas and Federal Land	2.56	2.77
Source: USDA Soil Conservation Service, Nebraska National Resources Inventory Tables, Lincoln, Nebraska, May 1994		

Figure 10

NEBRASKA LAND USE – 1992



Source: USDA Soil Conservation Service, Nebraska National Resources Inventory Tables, Lincoln, Nebraska, May 1994

Table 13
PERCENTAGE OF TOTAL HARVESTED ACREAGE AND PERCENTAGE OF TOTAL ACREAGE OF NEBRASKA IN INDIVIDUAL CROPS ON LAND IN FARMS IN 1959, 1974, 1987, AND 1992

	1959		1974		1987		1992	
	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage
All Corn	37.1%	13.7%	39.5%	13.1%	39.9%	12.4%	44.8%	14.8%
All Soy Beans	0.8%	0.3%	6.4%	2.1%	15.0%	4.7%	14.1%	4.6%
All Sorghum	8.6%	3.2%	11.7%	3.9%	8.5%	2.7%	8.8%	2.9%
All Hay	26.0%	9.6%	21.2%	7.0%	18.8%	5.9%	17.9%	5.9%
All Wheat	16.6%	6.1%	17.3%	5.8%	12.8%	4.0%	11.2%	3.7%
Total Acres Harvested	-----	36.8%	-----	33.3%	-----	31.1%	-----	32.9%
Irrigated Acres	-----	4.1%	-----	8.1%	-----	11.6%	-----	12.9%
Source: Percentages derived from figures in U.S. Department of Commerce, U.S. Census of Agriculture, 1959, 1974, 1987 and 1992.								

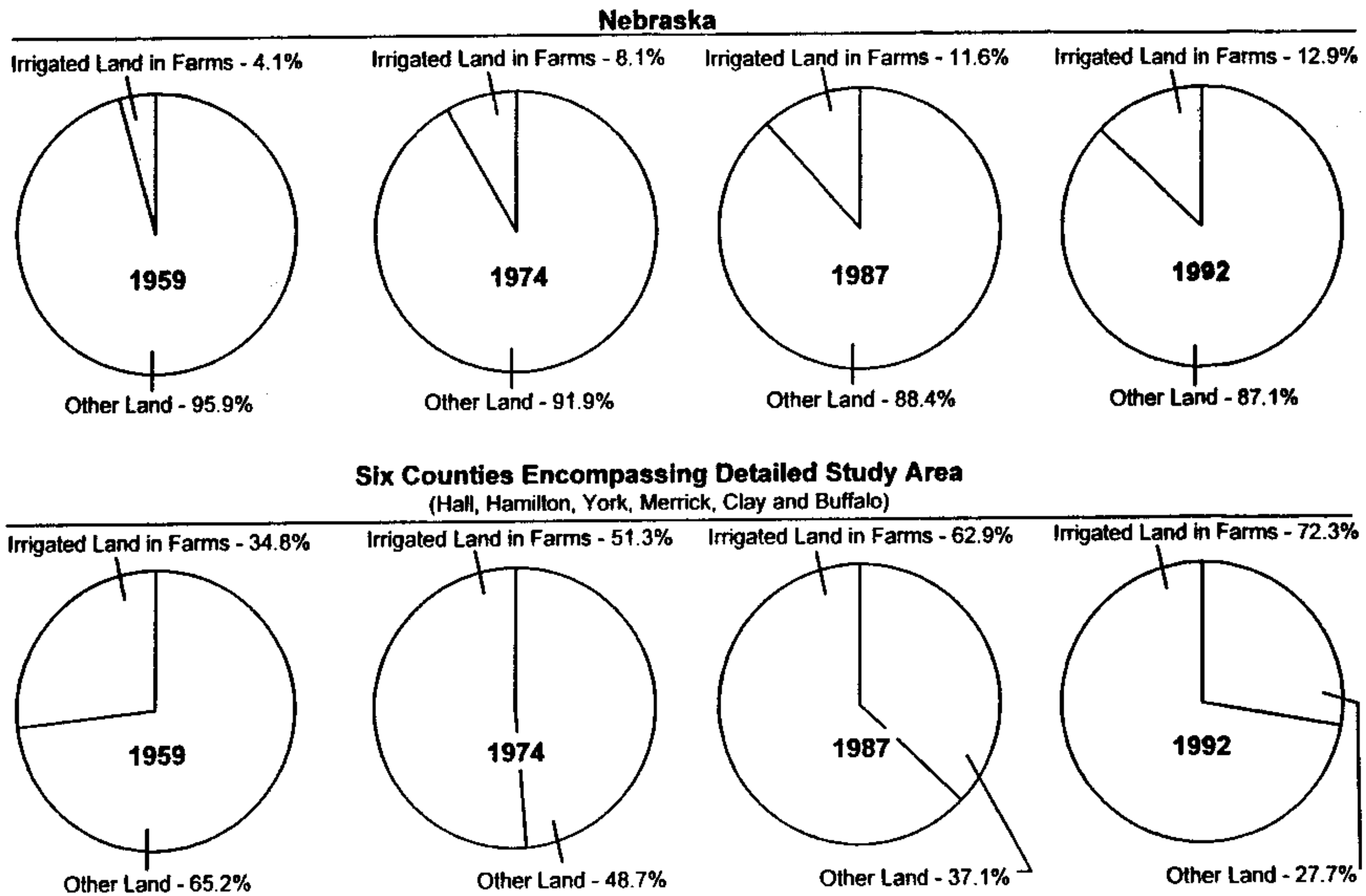
Table 14
PERCENTAGE OF TOTAL HARVESTED ACREAGE AND PERCENTAGE OF TOTAL ACREAGE OF COUNTIES IN INDIVIDUAL CROPS ON LAND IN FARMS IN 1959, 1974, 1987, AND 1992 IN SIX COUNTIES OF THE DETAILED STUDY AREA

	1959		1974		1987		1992	
	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage	% of Harvested Acreage	% of Total Acreage
All Corn	50.0%	46.7%	62.4%	54.9%	70.6%	56.0%	71.9%	66.5%
All Soy Beans	0.5%	0.5%	3.1%	2.7%	10.5%	8.3%	10.2%	9.5%
All Sorghum	15.0%	14.0%	15.2%	13.4%	7.6%	6.0%	8.1%	7.5%
All Hay	13.1%	12.2%	9.0%	7.9%	7.2%	5.7%	7.0%	6.5%
All Wheat	15.6%	14.5%	9.6%	8.5%	3.7%	2.9%	2.5%	2.3%
Total Acres Harvested	-----	93.4%	-----	88.2%	-----	79.3%	-----	92.5%
Irrigated Acres	-----	34.8%	-----	51.3%	-----	62.9%	-----	72.3%
Source: Percentages derived from figures in U.S. Department of Commerce, U.S. Census of Agriculture, 1959, 1974, 1987 and 1992.								

Figure 11

IRRIGATED ACRES ON FARMS AS A PERCENT OF TOTAL LAND AREA

Nebraska and Six Counties Encompassing Detailed Study Area
1959, 1974, 1987 and 1992



Source: Percentages derived from figures in Bureau of the Census, U.S. Department of Commerce, U.S. Census of Agriculture, 1959, 1974, 1987 and 1992.

Figure 12

Detailed Study Area Landuse Map

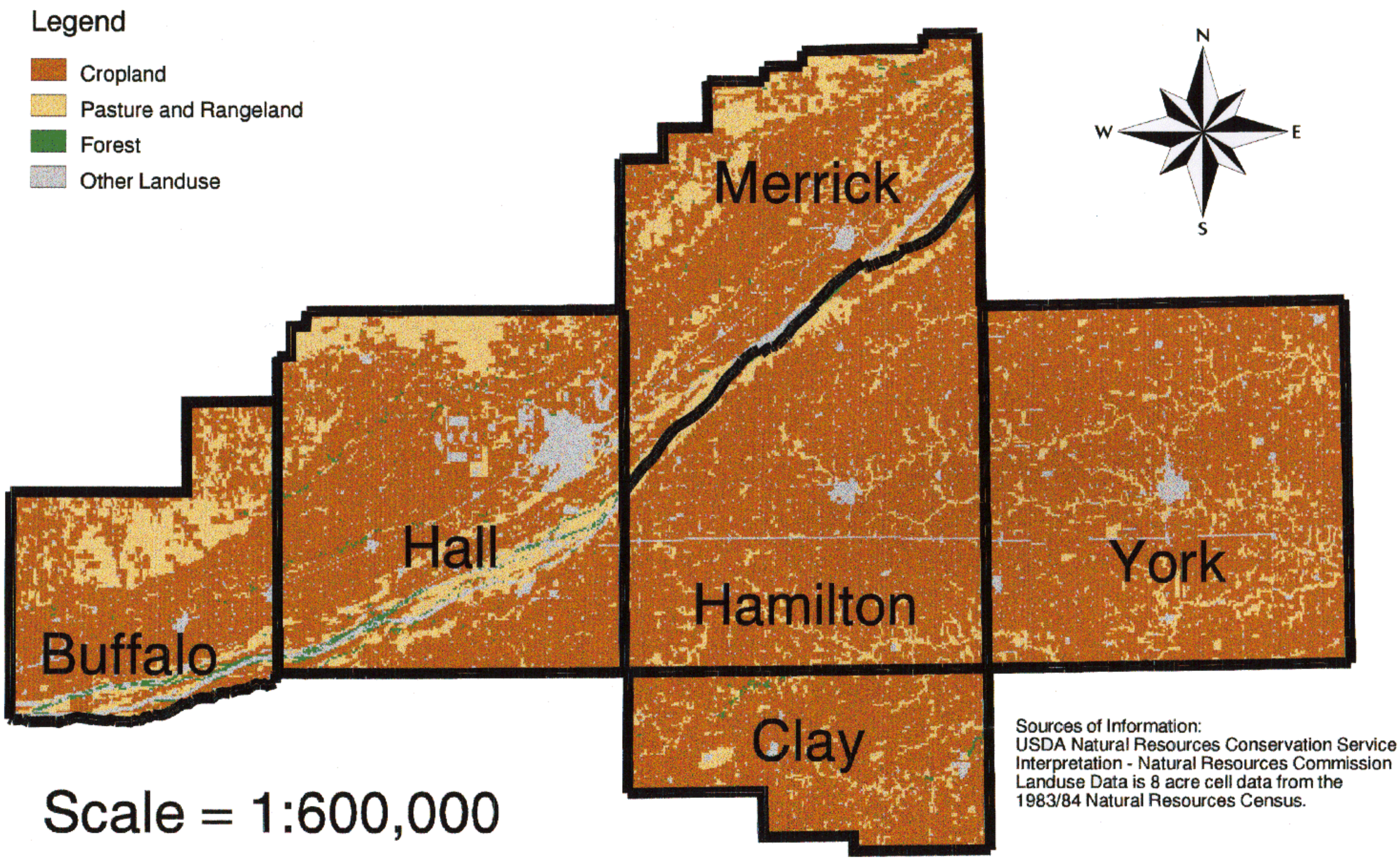


Table 15
Total Combined Land Use in Hall, Hamilton, York, Merrick, Clay and Buffalo Counties 1983-1984

Irrigated Cropland	63.0%
Dryland Cropland	13.4%
Pastureland/Rangeland	17.7%
Forested	0.8%
Other Uses	5.2%
Source: USDA Soil Conservation Service and Nebraska Natural Resources Commission, Nebraska Resources Census, 1983, 1984 (may not equal 100% due to rounding)	

Table 16
Fertilizer Tonnages Consumed in Nebraska 1960-1995

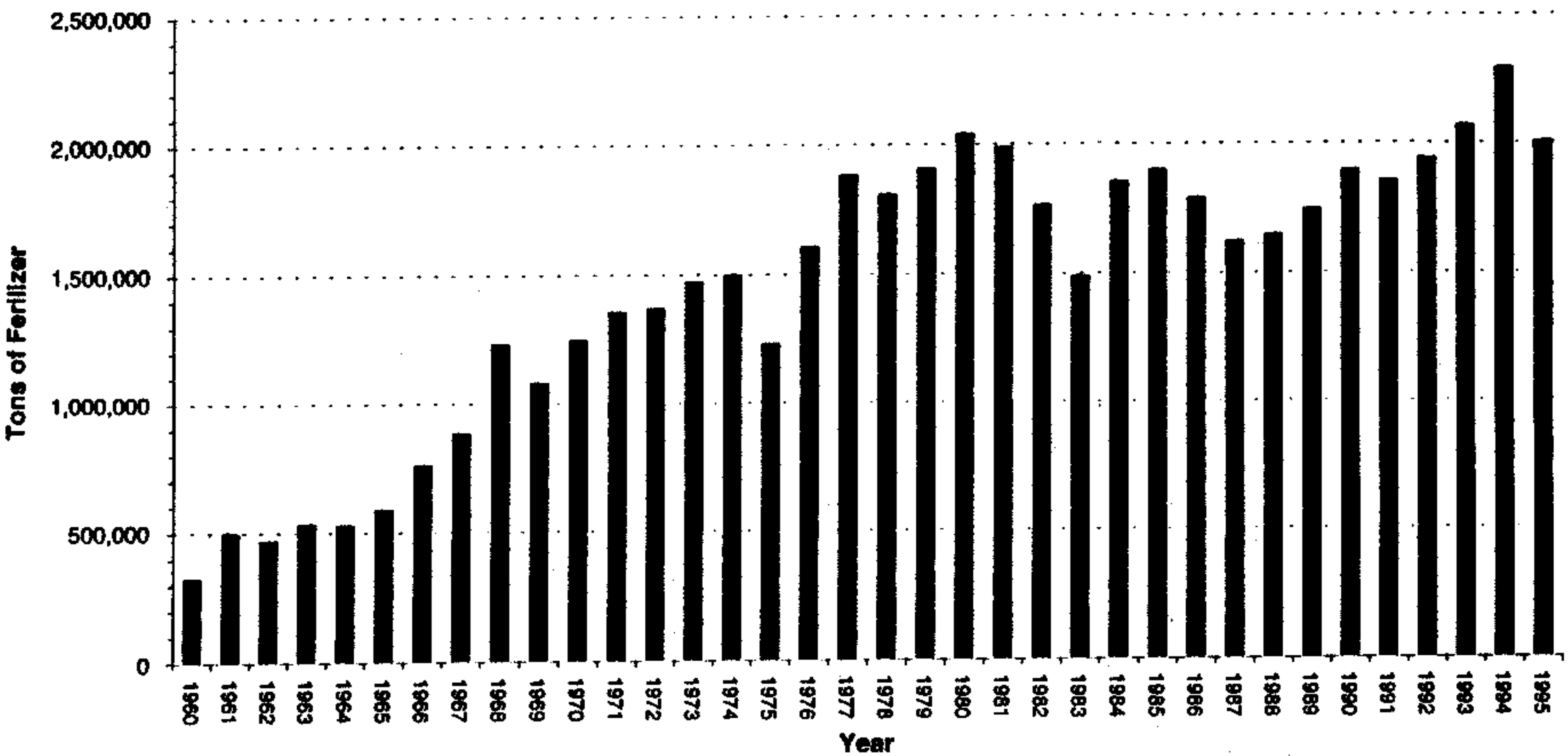
1960	321,934	1970	1,242,810	1980	2,033,489	1990	1,889,143
1961	492,552	1971	1,352,103	1981	1,983,364	1991	1,849,829
1962	465,203	1972	1,364,811	1982	1,757,909	1992	1,935,057
1963	529,052	1973	1,467,673	1983	1,484,550	1993	2,061,335
1964	524,459	1974	1,493,859	1984	1,849,455	1994	2,285,137
1965	583,194	1975	1,227,330	1985	1,893,977	1995	1,996,280
1966	753,285	1976	1,601,009	1986	1,783,870		
1967	878,417	1977	1,876,466	1987	1,616,855		
1968	1,226,820	1978	1,802,979	1988	1,639,353		
1969	1,075,518	1979	1,901,298	1989	1,737,019		
Source: U.S. Department of Agriculture, Nebraska Agricultural Statistics, various years.							

increases in agricultural productivity over the same period. It is worthy of note that the tonnages consumed have remained relatively stable since the late 1970s. It should also be noted that tonnages of fertilizer sold or consumed do not necessarily translate into tonnages of nitrogen. Table 17 presents total nitrogen in commercial fertilizer sold between 1965 and 1995.

While the increase in nitrogen applied does indicate increased potential for non-point source contamination, many other factors are also relevant. An increase in fertilizer use can indicate an increase in yields, area cropped or a change in the type of crop being raised. Fertilizers have been one of the major factors in agricultural productivity in the state. Corn for grain production is generally much higher now than in the early 1960s and soybeans are a far more prominent crop. In terms of groundwater contamination what matters is fertilizer not used by the crop and that makes its way to the groundwater. That can be related to soils, geology, and

Figure 13

ANNUAL TONNAGE OF FERTILIZER CONSUMED IN NEBRASKA 1960-1995



Source: Nebraska Agricultural Statistics Sevice, Nebraska Agricultural Statistics, Nebraska Department of Agriculture, various years

Table 17
Total Nitrogen in Commercial Fertilizer Consumed
or Sold in Nebraska - 1965-1995

Total N Consumed:	1965 = 230,337	1987 = 673,516	Total N Sold:	1990 = 725,200
	1970 = 499,003	1988 = 684,176		1991 = 751,683
	1975 = 491,955	1989 = 721,656		1992 = 755,104
	1980 = 826,275	1990 = 725,192		1993 = 728,972
	1985 = 806,408	1991 = 751,683		1994 = 887,135
	1986 = 747,601	1992 = 755,104		1995 = 703,750

irrigation/agricultural practice. Different fertilizer application practices, different fertilizers and different fertilizer characteristics are additional factors that can affect any impact fertilizer use may have on groundwater. Substantial progress has been made in these areas. Also fertilizer sales and use in an area may not always correspond. In addition tonnage sold does not necessarily correspond to the amount of nitrogen in the fertilizer. Thus use of fertilizer data should be viewed with caution.

Two points should be made about this state level data. Perhaps most important is that overall tonnages sold have remained fairly stable since the late 1970s. Thus while levels increased dramatically in the 1960s through mid-1970s there doesn't appear to be any trend to marked increases since that time. The second point is that the data varies markedly on an annual basis and the 1994 data is a "high" year. This can make percentage changes seem larger.

Detailed Study Area Fertilizer Sales

Table 18 provides data on fertilizer tonnage sold in the six counties encompassing the detailed study area. Tonnage sold in 1994 was at about 380% of 1962 levels. However, tonnage sold has decreased somewhat since 1980.

IRRIGATION WELL REGISTRATIONS AND PUBLIC WATER SYSTEM WELL REGISTRATIONS AND WATER USE

Irrigation well registrations and water use data are one indicator of trends in the intensity of water use in the state. Table 19 provides data on cumulative irrigation well registrations and public water system registrations in the state.

Cumulative irrigation well registrations rose at a high rate in the 1960's and 1970's but have not risen at as fast a pace since that time. Table 20 provides new registration of irrigation wells by year since 1976, the peak year for well registrations in the 1970's.

Table 18
Fertilizer Sold (in Tons) in Counties in the
Detailed Study Area 1962-1994

	York	Hamilton	Hall	Merrick	Clay	Buffalo	Six County Total
1962	10,040	12,003	9,843	8,941	14,886	13,406	69,119
1965	11,823.2	10,920.6	15,771.5	11,562.9	16,042.4	15,282.4	81,403
1970	25,833.9	28,916.3	26,482.0	35,135.7	31,574.9	34,790.2	182,733
1975	36,104.8	31,412.0	27,769.7	47,989.8	36,888.0	47,304.3	227,468.6
1980	40,855	38,938	50,490	51,142	60,287	54,360	296,082
1985	35,264	29,933	52,040	59,849	41,393	55,613	274,092
1990	36,688	57,624	37,510	40,826	44,410	48,751	265,809
1994	43,191	30,645	39,329	50,730	47,391	51,993	263,279
Source: U.S. Department of Agriculture, Nebraska Agricultural Statistics Annual Report, various years.							

Table 19
Cumulative Nebraska Irrigation
Well Registrations and Public Water System
Well Registrations

	Irrigation Well Registrations	Public Water System Well Registrations
1960	23,700	-----
1970	36,236	732
1980	69,044	1,157
1990	78,437	1,807
1996	84,501	2,082
Source: Nebraska Department of Water Resources		

Figure 14 provides a map of registered irrigation well locations in Nebraska. In 1995 irrigation accounted for an estimated 93.1% of total groundwater used in Nebraska. Groundwater in turn accounted for an estimated 81.3% of the water withdrawn for public supplies and all of the self-supplied domestic use (NNRC, April 1998). Figure 15 provides irrigation groundwater use in Nebraska counties. Table 21 provides a comparison of estimated irrigation use with public supplied and self-supplied domestic uses in 1995. The combined domestic use is only about 2.8% of irrigation use.

Figure 14
Nebraska Irrigation Wells Map

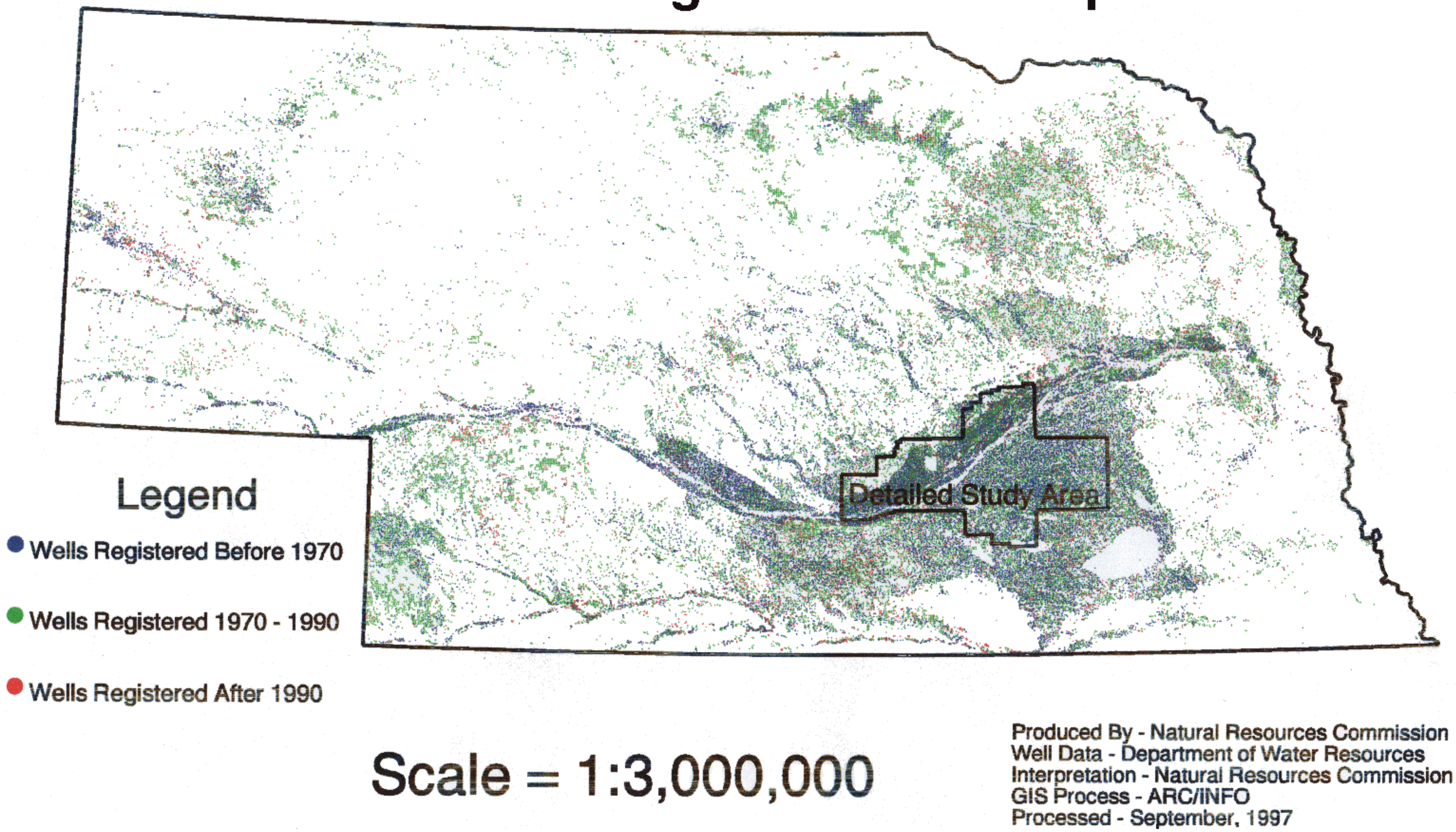


Figure 15
Estimated Irrigation Ground-Water Use in Nebraska, by County, 1995

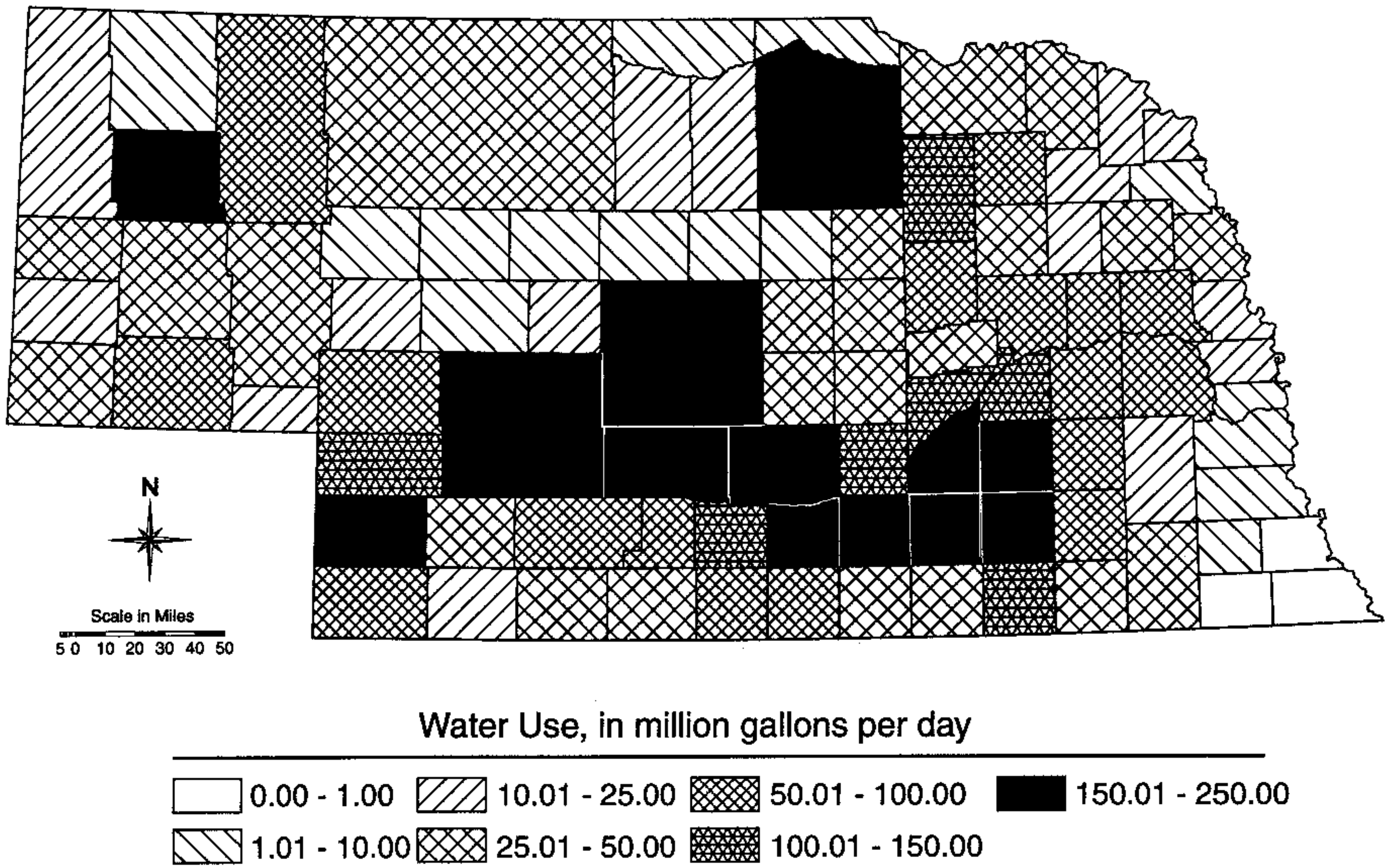


Table 20
Registration of Irrigation Wells in
Nebraska 1976-1996 New Registrations

1976	5,855		1987	268
1977	5,543		1988	470
1978	2,031		1989	1,201
1979	2,215		1990	1,268
1980	2,235		1991	1,078
1981	2,829		1992	1,381
1982	1,260		1993	759
1983	725		1994	808
1984	741		1995	830
1985	383		1996	1,208
1986	248			
Source: Nebraska Department of Water Resources				

Table 21
1995 Estimated Irrigation Water Use and Domestic Water Use

Estimated Irrigation Water Use in Million Gallons Per Day (MGD)	Estimated Domestic Water Use from Public Water Supplies in Million Gallons Per Day (MGD)	Estimated Self-supplied Domestic Water Use in Million Gallons Per Day (MGD)
6,996.38	155.41	41.85
Source: Estimated Water Use in Nebraska , 1995, Nebraska Natural Resources Commission, prepared in cooperation with the U.S. Geological Survey, Draft		

Detailed Study Area Irrigation Well Registrations, Public Water System Well Registrations and Water Use

Table 22 provides data on cumulative irrigation well registrations and public water system well registrations in the six counties encompassing the detailed study area.

The pace of irrigation well registrations in the detailed study area has decreased in recent years. Water use estimates for the six counties encompassing the detailed study area are available only for 1985, 1990 and 1995. Table 23 depicts irrigation water use totals and domestic water use totals from both self-supplied rural and public water supplies. The figures

Table 22
Cumulative Irrigation Well Registrations and Public Water System Well Registrations in the Six Counties Encompassing the Detailed Study Area

Year	Irrigation Well Registrations	Public Water System Well Registrations
1960	9,061	----
1970	12,107	58
1980	18,017	105
1990	19,849	191
1996	20,904	229
Source: Nebraska Department of Water Resources		

Table 23
Estimated Irrigation Water Use, and Domestic Water Use from Rural Self-Supplied and Public Water Supplies in the Six Counties Encompassing The Detailed Study Area 1985, 1990 and 1995*

	Estimated Irrigation on Water Use in Million Gallons Per Day (MGD)	Estimated Domestic Water Use from Public Water Supplies in Million Gallons Per Day (MGD)	Self-supplied Estimated Domestic Water Use in Million Gallons Per Day (MGD)
1985	856.4	11.95	2.42
1990	824.0	12.49	4.53
1995	1083.6	13.19	3.25
Source: Estimated Water Use in Nebraska 1990, Estimated Water Use in Nebraska 1995, Nebraska Natural Resources Commission			
* To be used for showing magnitude of uses rather than trends.			

are too short a time period to show trends and should be used with caution since the data collection and estimation process can result in differences. However, they do show the magnitude of the respective water uses.

Table 24 provides total estimated domestic per capita water use in each of the six counties and the state in 1985, 1990 and 1995. It does indicate a slightly higher per capita domestic water use than the state average.

Table 24
Estimated Total Per Capita Domestic Water Use in the Six Counties Encompassing the Detailed Study Area and in the State - 1985, 1990 and 1995*

Year	Buffalo	Clay	Hall	Hamilton	Merrick	York	State
1985	106	165	100	139	115	123	108
1990	141	138	143	139	143	99	117
1995	122	140	126	112	110	153	120
Sources: Estimated Water Use In Nebraska 1990, Estimated Water Use in Nebraska 1995, Nebraska Natural Resources Commission.							
* Due to difference in estimation technique this data should be shown for comparison of state and local amounts rather than to discern trends.							

LIVESTOCK NUMBERS

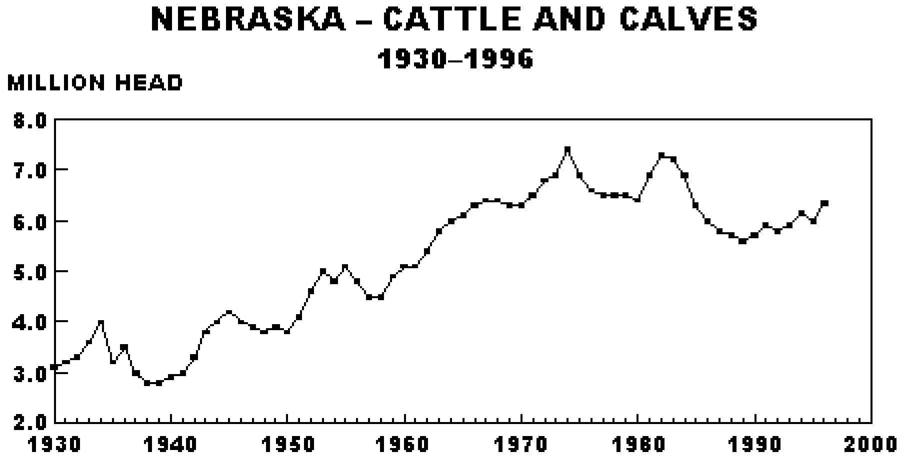
Livestock can be a source of nitrogen waste products and thus can be a threat to water quality if they are improperly managed. Table 25 provides changes in livestock numbers on farms in Nebraska since 1964. It shows an increase in hog and pig numbers of about 40% while the number of cattle and calves on farms actually declined slightly.

Table 25
Inventory Numbers of Cattle and Calves on Farms and Hogs and Pigs 1950-1992 (Thousands)

Year	Inventory # Cattle & Calves	Inventory # Hogs & Pigs
1950	3,843	2,499
1960	5,072	2,502
1970	6,330	3,000
1980	6,400	4,150
1990	5,700	4,200
1993	5,900	4,600
1996	6,350	4,100
	+65.23%	+64,06%
Source: Nebraska Agricultural Statistics Service, Nebraska Department of Agriculture, Nebraska Agricultural Statistics - 1995-1996		

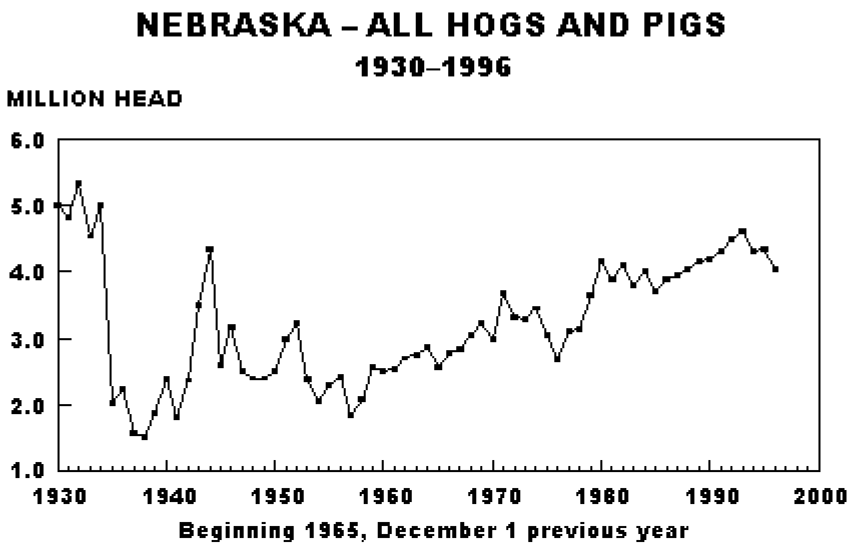
Figures 16 and 17 present graphs depicting change in cattle and calf numbers and hog and pig numbers in Nebraska since 1930. As of 1996 statewide inventories of cattle and hogs are up 65% and 64% respectively. However, cattle numbers were almost the same in 1996 as in 1970 and hog numbers were lower in 1996 than 1990.

Figure 16



Source: Reproduced from Nebraska Agricultural Statistics Service, Nebraska Department of Agriculture, Nebraska Agricultural Statistics 1995–1996

Figure 17



Source: Reproduced from Nebraska Agricultural Statistics Service, Nebraska Department of Agriculture, Nebraska Agricultural Statistics 1995–1996

Hog confinement facilities and hog and livestock waste disposal have recently been the subject of controversy in Nebraska. From the large number of licensing applications for hog confinement facilities in 1997 it appears that hog numbers may be up substantially since 1996. Nationwide, the literature on the level of groundwater threat posed by animal waste treatment or storage facilities appears mixed. Impacts to groundwater may sometimes depend upon facility construction, soil and geologic conditions or state requirements. Animal statistics would need to be monitored as they are made available to have the most accurate count. Livestock are a potential nitrogen source and there are combined about six times as many cattle and hogs in the state as people. Therefore livestock can sometimes be among the suspects in individual cases of contamination. Although the number of cattle and calves on Nebraska farms are not dramatically different than in 1964 the number of feedlots dropped from 22,984 in 1964 to 5,700 in 1994 with all of the decrease being in smaller feedlots of below 1,000 head. Exner and Spalding (1990) provided material indicating that in 1987 an estimated 235,000 tons of nitrogen were produced in Nebraska cattle and hog manure.

Detailed Study Area Livestock Numbers

Table 26 provides changes in livestock numbers on farms in the detailed study area since 1964.

Table 26
Inventories of Cattle and Calves on Farms
And Hogs and Pigs on Farms in the Detailed
Study Area Counties - 1964 to 1992

Year	Inventory # of Cattle and Calves on Farms	Inventory # of Hogs and Pigs on Farms
1964	377,539	211,098
1969	372,468	198,421
1974	380,279	216,204
1978	404,429	357,945
1982	423,348	406,196
1987	375,495	389,889
1992	393,660	427,312
% Change Between 1964 and 1992	+4.270%	+102.424%
Source: U.S. Bureau of the Census, Census of Agriculture, various years.		

SEPTIC TANKS

In some instances septic tanks can be a significant nitrogen source to private and public wells in addition to providing microbial threats to drinking water. Septic systems are generally in close proximity to private wells and an improperly constructed system can significantly influence drinking water sources. Septic tank construction, operation and abandonment is regulated in Nebraska, however the permit system operates on a voluntary basis. Several cities and counties require inspections as a condition of building permit issuance. Unpublished working estimates being used by some staff in the Department of Environmental Quality indicate that Nebraska probably has around 200,000 to 250,000 septic tanks and 8,000 to 10,000 septic tanks are probably being added per year (Goans 1998). The 1990 Census of Housing indicated that Nebraska housing units had 117, 460 septic tanks for Nebraska housing units.

OTHER LAND USE FACTORS

This section does not currently contain data on feedlots, location of waste lagoons or barnyards. Because of the proximity of those items to some private wells, management, construction or placement of those types of facilities can have a very significant effect on water quality. The Nebraska Department of Environmental Quality is in the process of creating a geographic information system that includes locations for facilities it regulates, such as feedlots.

POPULATION

Increased population can both pose a demand on available water supply and pose additional threats to its quality. Population is discussed in the Social/Economic portion of Task 2–1. Population in Nebraska has risen from 1,325,510 in 1950 to an estimated 1,652,093 in July 1996, an increase of 326,583 or almost 25%.

ENVIRONMENTAL SETTING

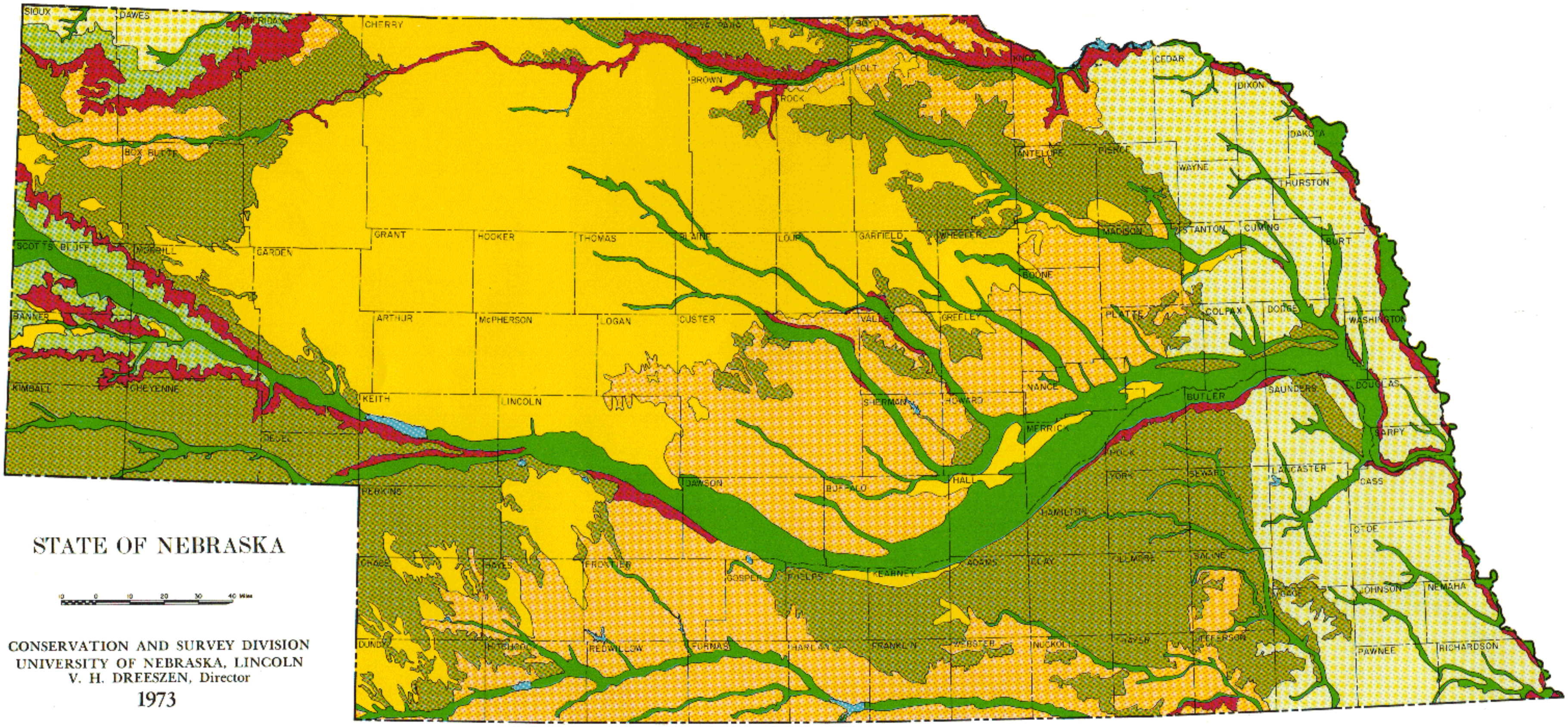
TOPOGRAPHY

Topography can constrain the degree to which land is utilized for irrigation or cropping. Other factors being equal, areas with less slope topography tend to have a higher proportion of land suitable for irrigation. Land with higher slopes can also have less pollution potential due to higher runoff and erosion rates that include the pollutants that infiltrate the soil.
Figure 18 presents a map of Nebraska's topographic regions.

Detailed Study Area Information

The six county detailed study area is mostly plains and valleys. As the map depicts, the rest of the state has less land in those categories. Therefore topography in the detailed study area is more conducive to irrigation development and any impacts that development may have on surrounding rural/small community water supplies. The detailed study area is comprised of portions of the Upper Big Blue River Basin and Central Platte River Basin. The Upper Big Blue River Basin is made up mostly of loess overlying thick silt, sand, and gravel deposits. The

Figure 18 — Topographic Regions Map



EXPLANATION

Valleys—flat-lying land along the major streams. The materials of the valleys are stream-deposited silt, clay, sand, and gravel.

Large Reservoirs—constructed for purposes such as water storage for irrigation, generation of electricity, flood control, or recreation.

Dissected Plains—hilly land with moderate to steep slopes, sharp ridge crests, and remnants of the old, nearly level plain. The Dissected Plains are old plains eroded by water and wind.

Rolling Hills—hilly land with moderate to steep slopes and rounded ridge crests. In eastern Nebraska, the Rolling Hills are mostly glacial till that has been eroded and mantled by loess, while in northwestern Nebraska the hills were produced by the erosion of clay and clay-shale beds.

Valley-Side Slopes—moderately sloping land which occurs between the escarpments and the major stream valleys in western Nebraska. These areas are mostly siltstone bedrock covered by a few feet to a few tens of feet of sand, gravel, or silt.

Plains—flat-lying land which lies above the valley. The materials of the plains are sandstone or stream-deposited silt, clay, sand, and gravel overlain by wind-deposited silt (loess).

Sand Hills—hilly land composed of low to high dunes of sand stabilized by a grass cover. The sand dunes mantle stream-deposited silt, sand and gravel, and sandstone.

Bluffs and Escarpments—rugged land with very steep and irregular slopes. Bedrock materials, such as sandstone, shale, and limestone, are often exposed in these areas.

northern portion of the basin is made up of a broad, flat plain which turns into gently rolling hills toward the central part of the basin with bedrock near the surface which crops out along some steep slopes. Major streams generally drain to the southeast and form valleys that have fairly broad flood plains and terraces. Drainage patterns are poorly defined in the flat plains of the northern part of the basin, but are better defined toward the central part in the rolling hills. Elevation of the entire basin ranges from 1970 feet above sea level near Hastings to 1,340 feet where the Big Blue River flows over the state line into Kansas.

In the Central Platte River Basin the area is divided into three topographic types: uplands, terraces, and flood plains. The uplands are highly dissected and mantled with loess. Terraces and flood plains were formed as the Platte River and its tributaries cut through the uplands. Terraces are made up of sands and gravels mantled by loess. In some areas the loess is reworked with sandy alluvium and in areas where the loess has been eroded, the terraces are covered with silty and clayey alluvium. Along the Platte River, terraces gradually merge into flood plains that are more extensive north of the river than they are to the south. The flood plains generally consist of tertiary sediments covered by sandy, silty, or clayey materials. The size of the materials in the flood plain depends on the energy of the river and depositional history during aggradation. Elevation of the Platte Valley ranges from 2,400 feet in the west part of the basin and declines to about 1,550 feet in the east.

CLIMATE

Statewide Data

Climatic factors can affect which crops are grown, rural/small community water demand, and the potential for leaching or runoff of nutrients and pesticides. Much of the climatic factor's potential effect on rural/small community water supplies in Nebraska is indirect — through influencing agriculture in an area. Drought can also be a major influence on both rural/small community and irrigation water demand. Demand during summer drought conditions can effectively help determine the level of community water supply infrastructure needed. Community landscape plant selection can affect the level of demand.

Nebraska has a markedly continental climate with full winters and hot summers. Temperatures vary markedly. Generally average temperatures decrease to the north and with the greater elevations to the west. Precipitation averages from less than 16 inches per year in parts of the panhandle to over 34 inches per year in the southeast corner of the state. There is extreme variation in precipitation from year to year and month to month. Generally May and June tend to be higher precipitation months than much of the remainder of the growing season. Variation annual precipitation has helped contribute to irrigation demand.

The marked variation in climate conditions in the state makes it unwise to extrapolate detailed study climatic factors to other areas of the state. However, the areas location in the east central part of the state may make it representative of more climatic conditions than some other areas would be.

Detailed Study Area Conditions

The study area has a typical continental-type climate including variable precipitation, low to moderate humidity, hot summers, and cold, severe winters, which is typical for mid-latitude regions. The warmest month is July with an average temperature of 75 to 78 degrees F; the coldest month is January with a 22 to 26 degree F temperatures. Temperatures may reach extremes as low as -40 degrees or up as high as 117 degrees F. Precipitation is unevenly distributed throughout the year. About 70 to 80 percent of the mean annual rainfall occurs during the growing season. Annual rainfall averages approximately 22 inches to the west and 29 inches to the east end of the Upper Big Blue basin. In the Central Platte basin, the mean annual precipitation ranges from about 19 inches in the west to 25 inches to the east. Rainfall in these areas generally occurs as localized thunderstorms. Variable rainfall patterns along with prevailing summer winds from the south and southwest can cause either prolonged droughts or isolated areas with excess moisture.

The normal growing season in the Upper Big Blue basin begins in the first week of April and lasts into the second or third week of October, normally 180 to 200 days. The growing season in the Central Platte basin is normally from April through September and is between 150 to 160 days. Precipitation is generally uniform throughout the region from September to April due to its cyclonic or frontal origin. High amounts of sunshine along with southerly winds result in potential evapotranspiration exceeding average annual precipitation.

SOILS

How Soils Can Affect Vulnerability to Contamination

Statewide Information

Soil conditions can influence small community and rural water supplies by affecting the infiltration rate of contaminants from the surface. The physical properties of soils, such as texture, structure, density, porosity, water content, and temperature determine the mobility of water into or through soils. The infiltration rate of a soil along with the slope will determine how much of the water applied to the soil surface will infiltrate and how much will run off over the surface. The infiltration rate is determined to a large extent by primary soil properties such as soil texture and the type of clay. Texture is the relative amounts of sand, silt, and clay in the soil. Coarse textured soils, those with a higher percentage of sand sized particles, will allow water to enter rapidly. This is because the spaces between the larger particles are large and well connected and will allow water to pass through quickly. The pores in fine textured soils, though there are many times more of them, are smaller and not as well connected and will allow water to enter slowly. If the soil is sloping, some of the water will run off over the surface.

Clay particles are the smallest soil particles. Generally, soils with a high percentage of clays do not transmit water very rapidly because the spaces between the clay particles are very small. Some clays will expand when wet and contract when dry. When these soils dry, cracks will form that will initially allow water to infiltrate rapidly. As the clays become wet, they will swell and the infiltration rate drops off rapidly. The effect of the primary properties is modified by secondary properties such as structure, density and porosity of the soil. Soil structure characterizes the way primary soil particles clump together to form larger aggregates. These aggregates function like the larger primary soil particles and can increase infiltration on a fine textured soil. Compacted soils will have less total pore space than uncompacted soils and the pores will be smaller. Compacted soils transmit water more slowly than loose uncompacted soils. The amount of organic matter, the moisture content, and the temperature of the soil will also affect infiltration. An increase in the amount of organic matter on the surface or mixed into the surface will increase the infiltration rate. Wet or frozen soils will not let water enter as rapidly as dry unfrozen soils.

Once the water has entered the soil, it is either stored in the soil, where it may be transpired by plants or evaporate from the surface, or it will percolate down below the root zone and eventually reach the surface of the groundwater. The soil properties that most affect this are permeability and the water holding capacity of the soil. Permeability is the quality of the soil that enables water to move downward through the profile. A soil's water holding capacity is defined as the amount of water that a soil will hold against the force of gravity. Soil texture and the type of clay present in the soil heavily influence both permeability and water holding capacity. Coarse textured soils are generally permeable and will have a low water holding capacity. Large particles have less surface area than small particles for a given volume of soil and will therefore hold less water. These soils are more prone to leaching than fine textured soils. Fine textured soils are generally less permeable and hold more water so a larger volume of water is required to move nitrates down below the root system of the crop.

Nitrogen in the Soil Profile

Nitrogen occurs naturally in soils and is the key element in plant growth. Nitrogen is most often the limiting element in plant growth and supplemental nitrogen is usually supplied cropland and turfgrass to compensate.

Ammonium. Naturally occurring (organic) nitrogen is decomposed to ammonium in a process called mineralization and supplies a significant amount of usable nitrogen to growing plants. Fertilizer nitrogen is often applied as ammonium or, if applied in another form, may be converted to ammonium. In basic solution, ammonium will lose a hydrogen ion to the solution and the ammonia gas will be lost to the atmosphere in a process called volatilization. Ammonium is soluble in water and is a usable (by plants) form of nitrogen. Ammonium is a positively charged ion and is held on the soil's cation exchange sites so it is not readily leached from the soil. Some of the ammonium will be taken up by plants or microbes and be converted to organic forms in a process called immobilization.

Nitrates. Much of the ammonium is quickly oxidized to Nitrite and then to Nitrate by bacteria in moist, well aerated soils. This process is called nitrification. Nitrate is the form of nitrogen most used by plants. Once converted, the nitrates will be immobilized, lost to the atmosphere, or lost to leaching. Under conditions of poor aeration, bacteria will use the oxygen from nitrates and the nitrogen gas remaining will be lost to the atmosphere. This is denitrification. Nitrate nitrogen is the most readily leached from the system. Nitrate is a negatively charged ion and is not held on the soil's cation exchange sites.

Leaching of nitrates from the soil is entirely controlled by the flow of water through the system. Water that is applied to the soil surface will run off the surface or infiltrate into the soil. Water that runs off will carry sediments and chemicals absorbed to the sediments to surface water bodies and may contribute to degradation of the surface waters. Water that infiltrates may evaporate, may be transpired by plants, may be stored in the soil, or percolate below the root system of the plants and recharge the groundwater. If the water contains nitrates, that which percolates below the root system of plants will also likely contaminate the groundwater. One of the factors that determine the amount of nitrates that leach out of the soil is the precipitation-evapotranspiration relationship. If more water is transpired than is applied to and infiltrates the soil, then there will be no water available to leach nitrates. If precipitation and infiltration exceeds evapotranspiration, then nitrates will be leached.

How Agricultural Management in Different Types of Soils may Affect Vulnerability to Contamination

Growing season leaching losses of nitrates can be controlled to some extent by proper fertilizer and irrigation management. Adjusting nitrogen fertilizer amounts to no more than is needed and timing the application to coincide with plant requirements will increase the likelihood that the plant will utilize the nitrates. Supplying no more water to the crop than the crop requires will reduce leaching losses because the crop will take up the water (and nitrate) and no water will percolate below the root zone. In coarse textured soils, this would require more frequent irrigation of smaller amounts of water to ensure that no more water was applied than could be stored in the soil. The greatest leaching risk occurs after the crop has been harvested when there are no plants to use the water. Research indicates that only a fraction (from 30 to 90%, commonly about 50%) of the nitrogen available to the crop is actually removed with the grain. Precipitation occurring during the off season is all available to leach residual nitrate below the root zone.

Preventative Measures

Use less nitrogen.
Use less mobile forms of nitrogen.
Timing of application and irrigation practices.
Growing season leaching losses of nitrates can be controlled to some extent by proper fertilizer and irrigation management. Adjust N fertilizer amounts to no more than is needed. Timing the application to coincide with periods when plant requirements are high increase the likelihood that the plant will utilize the NO_3. Supplying no more

water to the crop than the crop requires will reduce leaching losses because the crop will transpire the water and no water will percolate below the root zone.

Soils of Nebraska

Figure 19 presents a map depicting soil permeability in Nebraska. Permeability is the quality that enables water to move downward through the soil profile. Soil texture and soil water holding capacity are also important factors in the ability of nutrients to leach and are often related to permeability. Figure 20 presents soil texture in the state's major land resource areas (MLRA's). Major land resource areas are associations of areas with a particular pattern of soils, climate, water resources and land uses.

The soils in MLRA's 65 and 66 are formed in eolian sand or in residual material weathered from sandstone on the uplands and in sandy alluvium in the river valleys. These are soils of the Valentine, Thurman, Holt and Dunday series. These soils are mostly coarse textured, are moderately rapid to very rapidly permeable, and have a low water holding capacity.

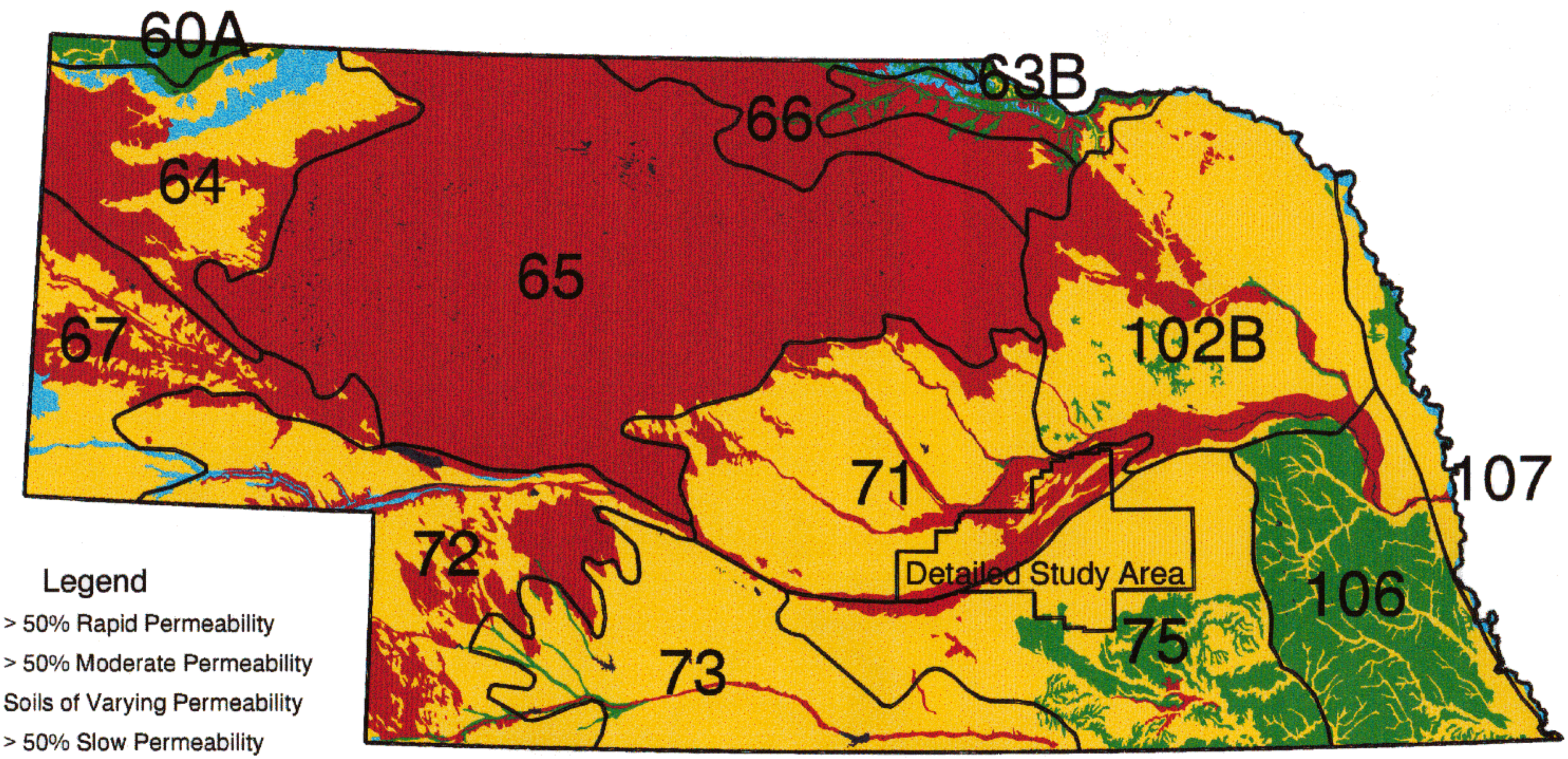
The soils in MLRA's 73, 71, 102B, and 107 are formed in coarse loess parent materials and coarse textured to fine textured alluvium in the river valleys. These are soils of the Keith, Holdrege, Crete, Ulysses, Nora, Moody, Crofton, Monona and Marshall series on the uplands. Soils of the Hall, Hord, and Woodriver series formed on the terraces of the Platte River. Soils of the Platte and Leshare series formed in the coarse textured alluvium on the Platte River bottoms. Luton and Haynie soils formed in the fine textured alluvium of the Platte and Missouri River bottoms. The upland soils are medium textured and are moderately permeable. Available water capacity on these soils is high. The terrace soils are medium to fine textured and the permeability of these soils ranges from moderate to very slow. The Platte and Leshare soils are coarse textured and rapidly permeable. The Luton and Haynie soils are slowly to moderately permeable and the available water capacity is medium to high.

The soils in MLRA's 75 and 106 are fine are formed in fine textured loess and loess over glacial till. Hastings, Crete, Fillmore, and Wymore soils formed in loess and the Shelby, Pawnee, and Burchard soils formed in glacial till. These are all fine textured soils and permeability ranges from moderate to very slow. Available water capacity in the loess soils is high and slightly lower in the till soils.

The soils in MLRA's 60A and 63B are fine textured soils formed in residual material weathered from shale. The soils in these areas are of the Pierre, Samsil, Reliance, and Boyd series. Permeability is slow to very slow in these soils and available water capacity ranges from low in the Samsil to high in the Reliance.

The soils in MLRA's 64, 67, and 72 formed in loess and eolian sand, in sandstone and siltstone, and in alluvium. The soils formed in the sandstone residium are medium textured, moderately permeable, and have a medium available water capacity. Rosebud and Canyon soils

Figure 19
Major Land Resource Area and Soil Permeability Map



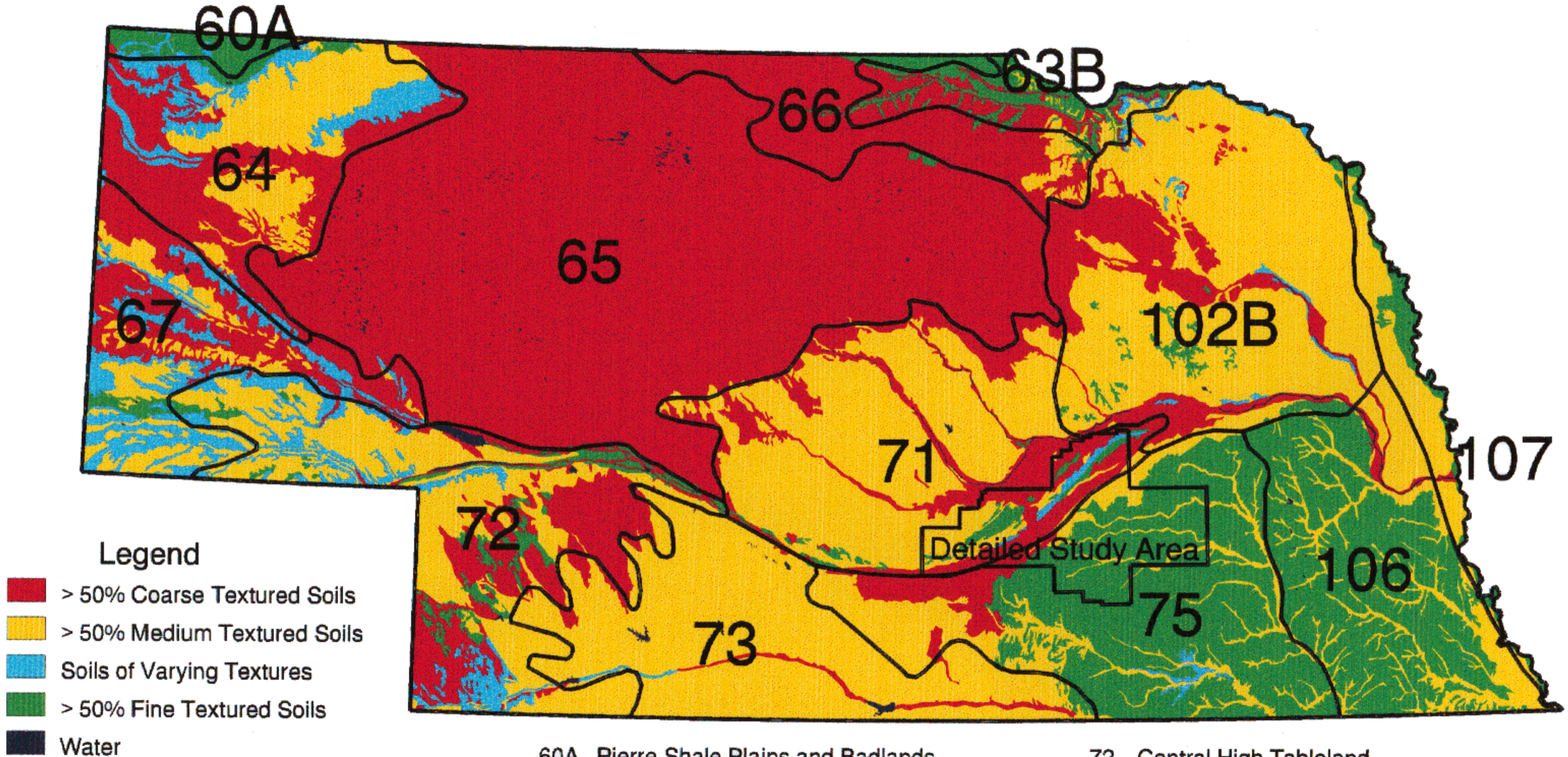
Legend

- > 50% Rapid Permeability
- > 50% Moderate Permeability
- Soils of Varying Permeability
- > 50% Slow Permeability
- Water

Produced By - Natural Resources Commission
STATSGO Soils Data - NRCS
Interpretation - Natural Resources Commission
GIS Process - ARC/INFO
Processed - September, 1997

60A Pierre Shale Plains and Badlands
63B Southern Rolling Pierre Shale Plains
64 Mixed Sandy and Silty Tableland
65 Nebraska Sand Hills
66 Dakota-Nebraska Eroded Tableland
67 Central High Plains
71 Central Nebraska Loess Hills
72 Central High Tableland
73 Rolling Plains and Breaks
75 Central Loess Plains
102B Loess Uplands and Till Plains
106 Nebraska and Kansas Loess-Drift Hills
107 Iowa and Missouri Deep Loess Hills

Figure 20
Major Land Resource Area and Soil Texture Map



60A Pierre Shale Plains and Badlands
63B Southern Rolling Pierre Shale Plains
64 Mixed Sandy and Silty Tableland
65 Nebraska Sand Hills
66 Dakota-Nebraska Eroded Tableland
67 Central High Plains
71 Central Nebraska Loess Hills
72 Central High Tableland
73 Rolling Plains and Breaks
75 Central Loess Plains
102B Loess Uplands and Till Plains
106 Nebraska and Kansas Loess-Drift Hills
107 Iowa and Missouri Deep Loess Hills

Produced By - Natural Resources Commission
STATSGO Soils Data - NRCS
Interpretation - Natural Resources Commission
GIS Process - ARC/INFO
Processed - September, 1997

fall into this category. Valentine and Dunday soils formed in eolian sand are coarse texture, rapidly permeable and have a low available water capacity. Mitchell and Tripp soils formed in siltstone, are medium textured, moderately permeable and have a high available water capacity. Keith soils, formed in loess, are moderately permeable and have a high available water capacity. McCook and Las soils formed in the medium textured alluvium, are moderately permeable and have a medium to high available water capacity.

Vulnerability to Contamination (DRASTIC Mapping)

DRASTIC is a groundwater quality index for evaluating the pollution potential of large areas using the hydrogeologic settings of the region. Much is known about the circumstances and conditions that influence a site's susceptibility to groundwater contamination. It is useful to use this information to predict where conditions exist that would make groundwater contamination more or less likely. EPA developed this model in the 1980's. A hydrogeologic setting is defined as a mappable unit with common hydrogeologic characteristics. The hydrogeologic characteristics describe the physical properties of the site that control the flow of water through the various geological layers from the surface of the ground to the surface of the groundwater. This model employs a numerical ranking system that assigns relative weights to various parameters that help in the evaluation of relative groundwater vulnerability to contamination.

The hydrogeologic settings, which make up the acronym **DRASTIC** are:

Depth to water table — Shallow water tables pose a greater chance for the contaminant to reach the groundwater surface as opposed to deep water tables.

Recharge (net) — Net recharge is the amount of water per unit area of the soils that percolates to the aquifer. This is the principal vehicle that transports the contaminant to the groundwater. The more the recharge, the greater the chances of the contaminant to be transported to the groundwater table.

Aquifer Media — The material of the aquifer determines the mobility of the contaminant through it. An increase in the time of travel of the pollutant through the aquifer results in more attenuation of the contaminant.

Soil Media — Soil media is the uppermost portion of the unsaturated/vadose zone and is characterized by significant biological activity. This along with the aquifer media decides the amount of percolating water to the groundwater surface. Soils with clays and silts have larger water holding capacity and thus increase the travel time of the contaminant through the root zone.

Topography (Slope) — The higher the slope, the less is the pollution potential due to higher runoff and erosion rates, which include the pollutants that infiltrate into the soil.

Impact of the Vadose Zone — The unsaturated zone above the water table is referred to as the vadose zone. The texture of the vadose zone determines the time of travel of the contaminant through it.

Conductivity (Hydraulic) — Hydraulic conductivity of the soil media determines amount of water percolating to the groundwater through the aquifer.

Each DRASTIC factor has been assigned a rating for different ranges of the values. Higher values indicate a more vulnerable condition. For example, soil media is rated from 1 to 10 depending on the textural class to which it belongs. A very porous media or an absent media receives a rating of 10, while a non-shrinking, non-aggregated clay media receives a rating of 1. In addition, each DRASTIC factor has been evaluated with respect to the others to determine the relative importance of each factor. Each has been assigned a relative weight ranging from 1 to 5. The most significant factors have weights of 5; the least significant, a weight of 1. In the modified agricultural DRASTIC model, the depth to groundwater and the soil media are the most important characteristics affecting vulnerability and are given a relative weight of 5.

The major assumptions outlined in DRASTIC are:

The contaminant is introduced at the surface.
The contaminant reaches groundwater by precipitation.
The contaminant has the mobility of water.
The area of the study site is greater than 100 acres.

A DRASTIC map depicting general vulnerability to contamination in Nebraska is provided as Figure 21. Vulnerabilities tend to be higher in river valleys, the Sandhills, and Sandhills fringe and portions of the Panhandle, the Upper Republican, Upper Elkhorn and Upper Blue Basins. In order to better understand existing vulnerability to contamination, this map should be compared with the land use map in Figure 9 and the irrigation wells map provided in Figure 14. Areas with cropping, irrigated cropping and urban uses have relatively more potential for placing contaminants on the soil surface than range uses. In general, the detailed study area has higher vulnerability to contamination and a higher proportion of cropped land and irrigation wells and irrigated acreage than other areas of the state.

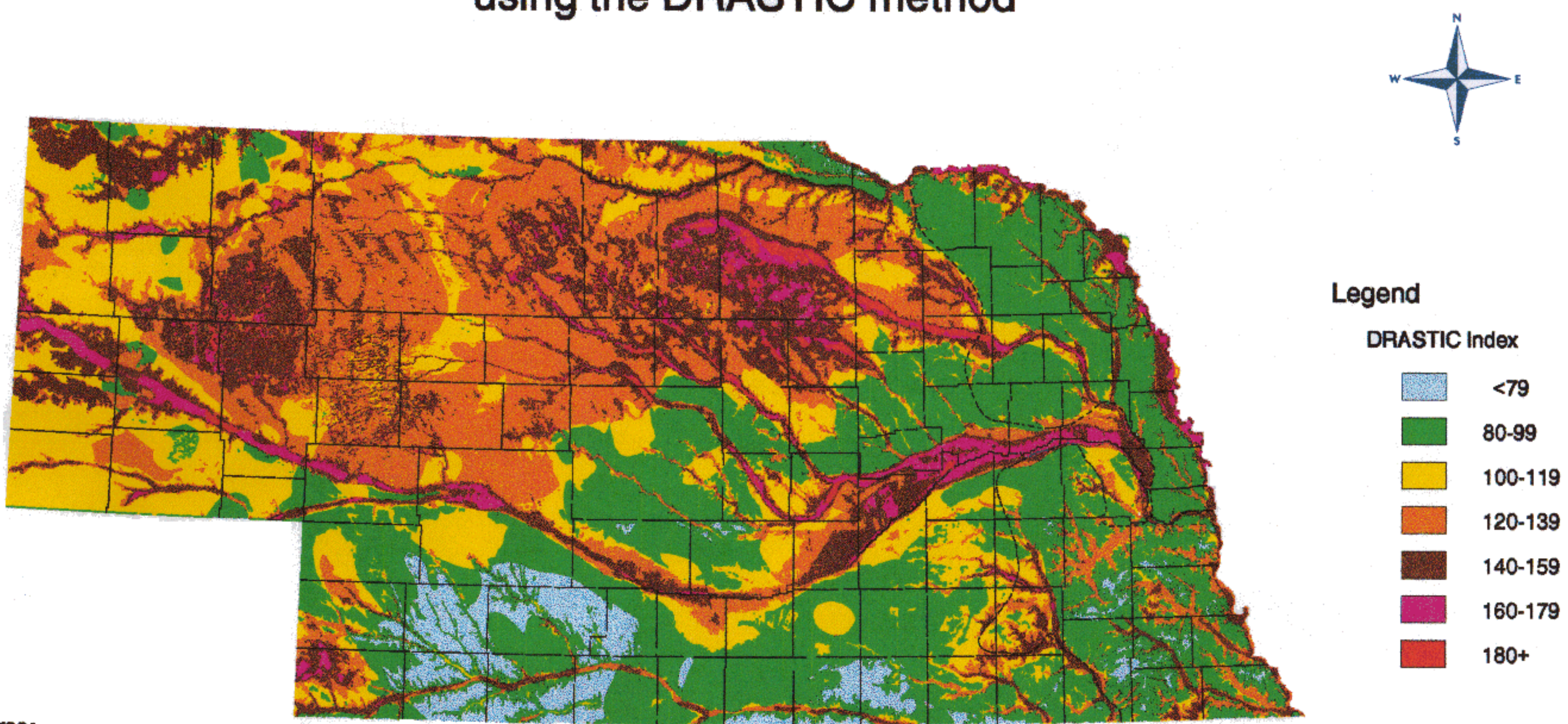
Soils - Detailed Study Area Conditions

The detailed study area encompasses all or part of 6 counties along the Platte River in the Central Platte and Upper Big Blue Natural Resources Districts. The counties, Buffalo, Hall, Merrick, Hamilton, Clay, and York, encompass approximately 2.3 million acres. About 66% of the soils in this 6 county area are formed in Loess. Twenty-eight percent were formed in alluvial materials and about 6% were formed in eolian sand.

NEBRASKA NATURAL RESOURCES COMMISSION

DATA BANK

Figure 21
Potential Groundwater Vulnerability to Contamination using the DRASTIC method



Information Source:

Produced by - ***Nebraska Natural Resources Commission***
Model - ***U.S. Enviornmental Protection Agency, and National Water Well Association***
Data Source - ***Department of Enviornmental Quality, Center for Advanced Land Management Information Technoogies. Conservation and Survey Division, UNL***
DRASTIC Parm ***Depth to Groundwater, recharge, Acquifer media, Soil Media, Topography (slope), Influence of Vedose Zone, and Hydraulic Conductivity***
GIS Process - ***ARC/INFO***
Processed - ***October 1996***

NOTE: This map is for planning purposes only and is not intended to be used for site-specific applications.

DRASTIC indices east of the dashed line represent only the vulnerabilities of the upper most ground-water level.

As previously mentioned one factor very relevant to whether nutrients can leach through soils to reach the water table is permeability. Permeability is the quality of soil that enables water to move downward through the soil profile. Figure 22 presents a map of permeability in the detailed study area. Permeability is rapid to very rapid in the sandy and coarse-loamy soils along the northern extremes of Hall and Merrick counties. These soils include the Valentine and Thurman soils on the uplands and O'Neill soils on terraces and bottomlands along the Platte River. Permeability is moderately rapid in the coarse textured alluvial materials on the terraces and bottomlands of the Platte River. These soils include Ortello on terraces and Wann, Platte, and Janude soils on the bottomlands. The moderately permeable soils are the loamy and silty soils and include the Holder, Coly, and Holder soils, formed in loess on the uplands on either side of the Platte River, and the Hobbs and Hord soils. Hord soils were formed in alluvial materials on terraces and the Hobbs soils were formed in alluvial/colluvial materials along upland drainages. Soils with moderately slow permeability include the Hastings soils, which formed in loess on the uplands south of the Platte River. Hastings soils are fine textured soils and comprise 25% of the soils in the 6 counties in the detailed study area. Soils in the slow and very slow permeability classes include the Crete soils which were formed in fine textured loess on the uplands south of the Platte, and the Woodriver soils which were formed in fine textured materials on terraces north of the Platte River.

A DRASTIC map of the detailed study area is included as Figure 23. The DRASTIC map shown is clipped from a map created at a scale of 1:250,000. This map does not show the level of detail desirable in a large-scale map but is a compromise between the need to develop the data and the availability of the information required to develop it. The map shows that the Platte River soils and those areas north of the Platte are generally more vulnerable than those areas south of the river. The Platte River soils are moderately to rapidly permeable and they have shallow depths to groundwater. North of the river there are large areas where the soil permeability is rapid. South of the river, most of the soils are slowly or very slowly permeable.

There is concern about nitrate found in the vadose zone in the study region. The vadose zone is the unsaturated area (including soils) between the surface of the land and the regional water table. Studies by the UNL Water Center show that nitrates appear to move deeper in the vadose zone over time. Water samples taken from test plots in Clay County (1985) had elevated nitrate levels which peaked at a depth of 9 m (~30 ft). In samples taken five years later (1990), the nitrate peaks appear to have moved vertically downgradient to a depth of 12.5 m (~41 ft). Water from rain or melting snow seeping through the vadose zone leached exceed nitrates from the soil or root zone and moved it downward as it drained toward the water table (UNLWater Center, 1995). Rate of movement depends on the soil type and host material on which it formed. Water and agrichemicals move more rapidly through coarse sands than through fine, clayey materials.

Figure 22

Detailed Study Area Soil Permeability Map

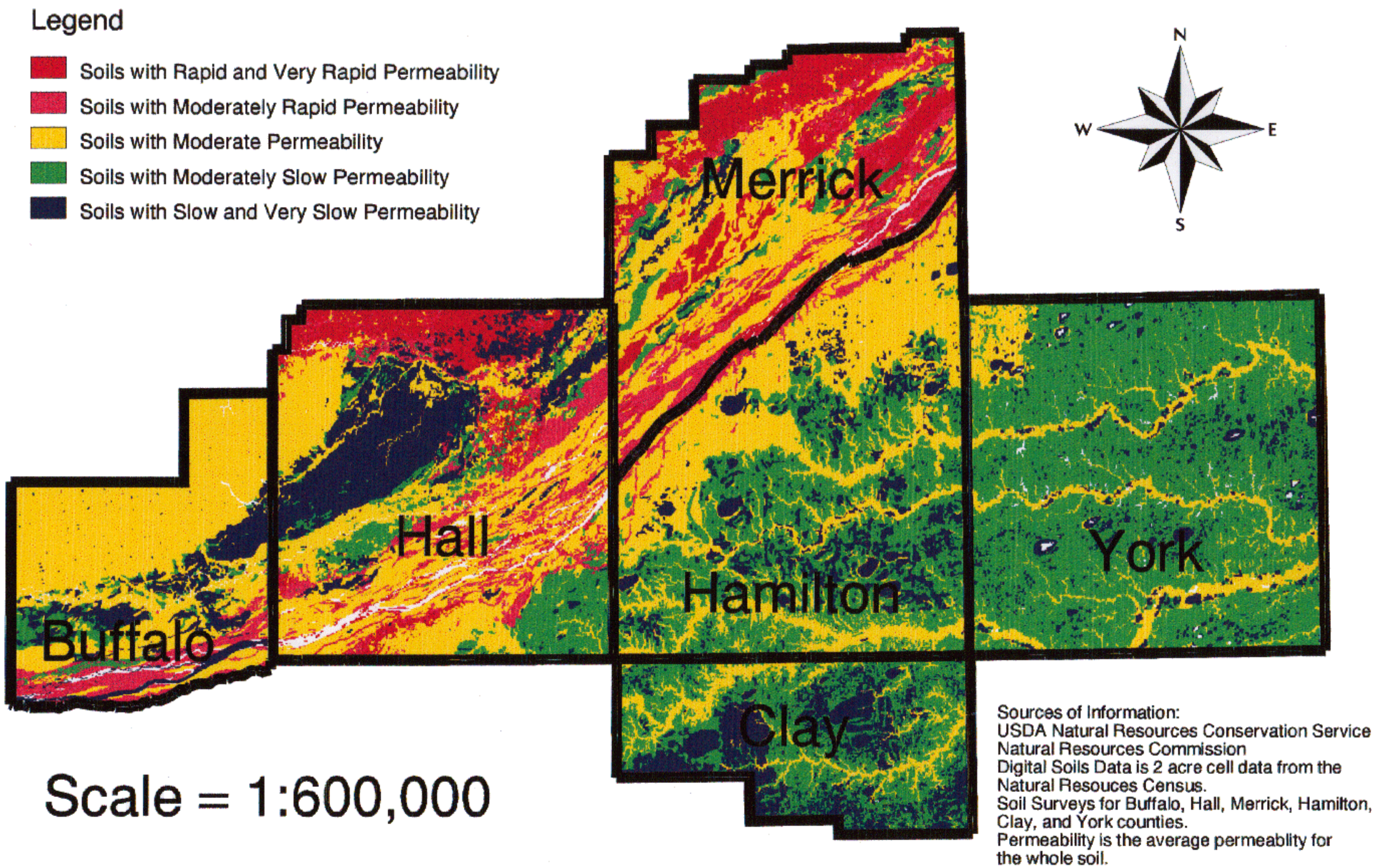
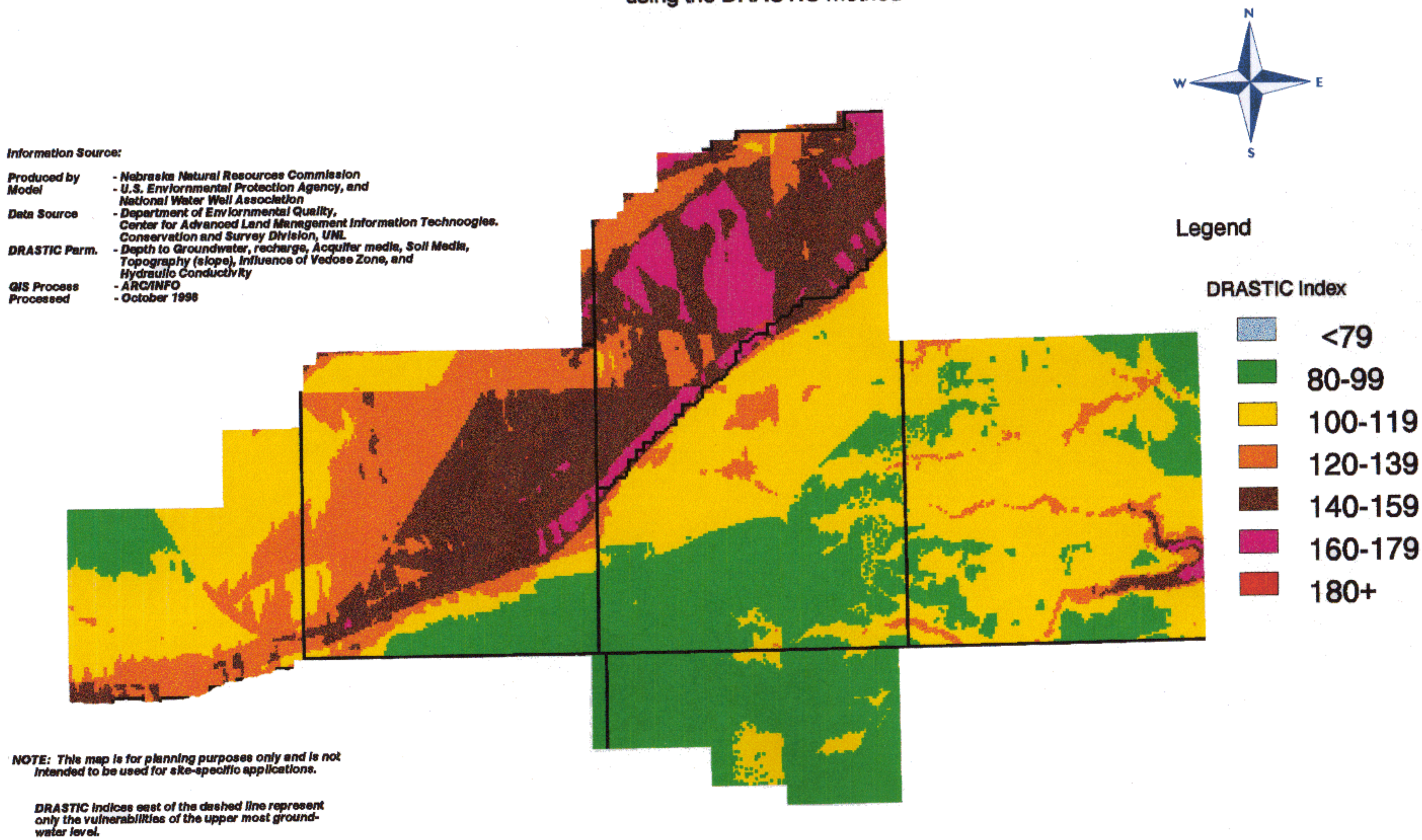


Figure 23

Potential Groundwater Vulnerability to Contamination

using the DRASTIC method



NATIVE VEGETATION

State Level Conditions

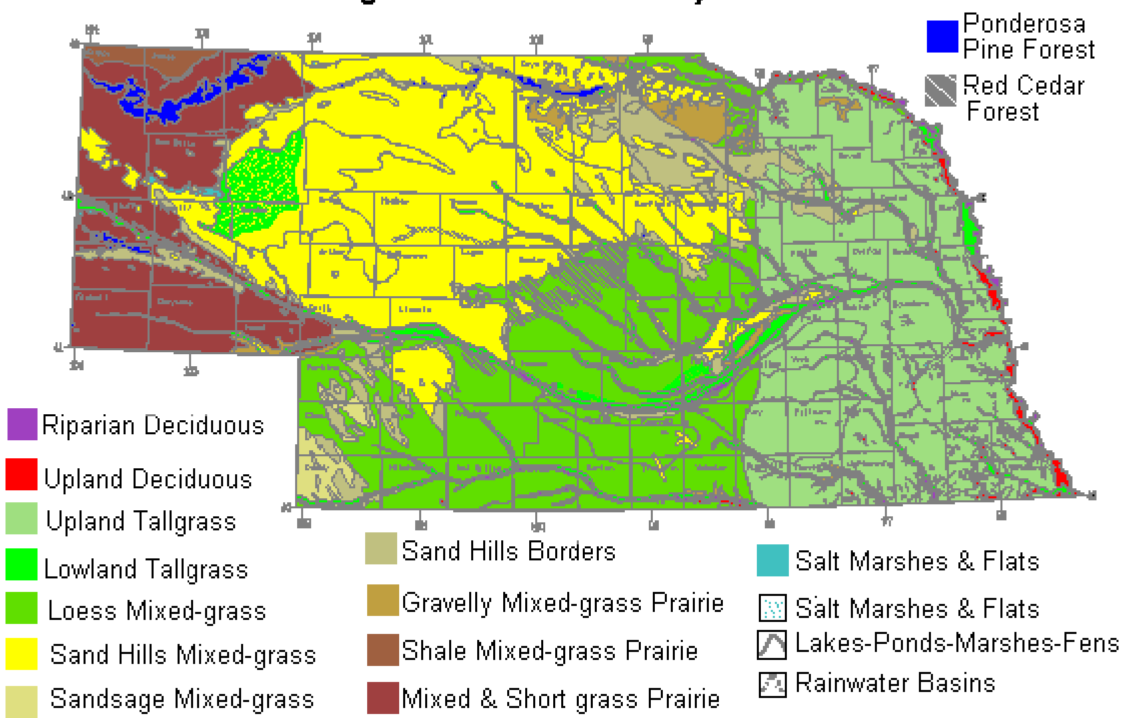
Figure 24 provides a native vegetation map for the State of Nebraska as produced through the University of Nebraska-Lincoln Conservation and Survey Division. Generally range and native vegetation are less likely to have an effect on groundwater supplies that cropped land or land in urban uses.

Detailed Study Area Conditions

The study area supports diverse native vegetation owing to varying soils and topography and the general decrease in annual precipitation from east to west. There is a transition from tallgrass to mixed grass prairie across the area and Sandhills vegetation is present in certain parts of Hall and Merrick counties. The study area is also distinguished by the Platte River and its associated riparian and wetland habitats. The following types of native vegetation as identified and described by Kaul and Rolfsmeier are present:

Figure 24
Native Vegetation

Source - "Native Vegetation of Nebraska" by R. B. Kaul & S. B. Rolfsmeier



(1) Upland tallgrass prairie: Originally occurred in York, the eastern half of Hamilton, and the eastern two-thirds of Clay counties but now restricted to a few remnant tracts in the study area. Common grasses are big bluestem, little bluestem, Indian grass, porcupine grass, prairie dropseed, sideoats grama and switchgrass. Forbs and shrubs are primarily of the pea and sunflower families and include bush clover, ground-plum, leadplant, wild-indigos, prairie clovers, scurf peas, asters, blazing stars, coneflowers, Compass plant, and native thistles.

(2) Lowland tallgrass prairie: Originally present in the valleys of the Platte River and its larger tributaries across the study area and also along Lincoln Creek in eastern York County. Vegetation is dense and often luxuriant. Many species of the upland tallgrass prairie are present but also common are various sedges and grasses such as Canada wild rye and prairie cordgrass. Additional forbs include scouring rush, golden alexander, Illinois bundleflower, Maximillan's sunflower, rosinweed, prairie gentian, and prairie fringed orchid. Most of this vegetative type has been converted to cropland or is mowed and/or grazed.

(3) Loess mixed-grass prairie: Originally present from central Hamilton County to the western boundary of the study area and beyond. Most has been converted to cropland but some sizable tracts remain, especially along the bluffs of the Platte River. Prominent grasses include big bluestem in moister sites, and little bluestem, sideoats grama, blue grama, needle-and-thread, Junegrass, and buffalo grass. Forbs and shrubs are fewer in species as compared to tallgrass prairie and include locoweeds, milk vetch, prairie coneflower, prairie clovers, leadplant, scurf peas, asters, and blazing stars.

(4) Sandhills mixed-grass prairies: Originally found in north central Hall county and northwestern Merrick County, sizable tracts still remain. A distinctive vegetation zone of tall and short rhizomatous and bunch grasses and many forbs but the vegetation is not as dense as in the tallgrass and mixed-grass prairies. Grasses include blue grama, hairy grama, Indian grass, sand bluestem, little bluestem, needle-and-thread switchgrass and prairie sandreed. Forbs and shrubs include lead plant, prairie rose, sand cherry, various penstemons, prickly-pear cactus, prairie clovers, spiderwort and western ragweed. Plant species composition varies with location on the sand dunes and in the interdunal valleys.

(5) Sandhills borders mixed-grass prairie: Also originally present in northcentral Hall and northwestern Merrick counties. A greater portion of this vegetation type has been converted to cropland as compared to the Sandhills mixed-grass prairie. Plant species restricted to pure sand or to non-sandy soils are absent.

(6) Gravely mixed-grass prairie: Originally present in a four to five mile wide band extending from southwestern to northeastern Merrick County. This area is mostly unsuited for cropland so has not been extensively connected to cropland. Some Sandhills species, such as yucca, sand lovegrass and prickly-pear cactus, are present along with some species not otherwise found in sandy prairies such as prairie fameflower, prairie sagewort, slender Knotweed, smooth sumac, and Virginia ground cherry.

(7) Riparian forest along the Platte River. Woody vegetation is typically of early successional species with open woodlands. Shrub and herbaceous growth can be dense. Species include cottonwood, willows, red cedar, green ash, hackberry, and the introduced Russian olive. There are fewer species of trees, vines, shrubs, and herbs than in other riparian zones to the east. Little of this has been converted to cropland but grazing is common.

(8) Rainwater Basin: This area, which originally contained numerous shallow permanent and intermittent ponds and marshes, included all of York and most of Hamilton and Clay counties. Plant species include cattails, bullrushes, arrowhead, and spike rushes. Most of the basins have been converted to cropland, only about 10% remain.

(9) Salt marshes and flats: Originally occurred in a five to six mile wide band north of the Wood River in western Hall County and eastern Buffalo County. Vegetation is patchily distributed with large expanses of bare soil that is often white with encrusted salt when dry. Common plants are alkali cordgrass, alkali plantain, alkali sacaton, arrowgrass, saltgrass, seablite, and spearscale. Mostly degraded, grazed, or converted to cropland.

FISH AND WILDLIFE

Generally, there is not a strong relationship between fish and wildlife and environmental factor affecting rural/small community water supplies. However, there are a few instances in which a potential relationship may be worth mentioning. Agricultural water quality best management practices which benefit source water for rural/small community supplies can also benefit surface water quality and the fish and wildlife dependent on that surface water. That may be through either lessening the direct runoff of contaminants in rainfall events or through improving the quality of groundwater that later become stream baseflow.

In addition a landuse change for wellhead protection could conceivably be used for or benefit fish and wildlife.

Detailed Study Area Conditions

The fish and wildlife resources of the study area are generally comprised of those species common to cropped areas of the eastern Great Plains along with species associated with the Platte River and its attendant habitats. Species common to the Sandhills are also present in certain portions of Hall and Merrick counties.

The Platte River supports a significant fishery with channel catfish and carp as the most important sport species. Other fish, including longnose gar, shortnose gar, shovelnose sturgeon, carpsuckers, bullheads, and various minnows and shiners, are also present. Some Platte River tributaries, such as the Wood River, Prairie Creek, and Silver Creek, along with tributaries of the Big Blue River in Hamilton and York counties, namely Lincoln Creek and Beaver Creek, support some of these same species but primarily minnows and shiners. Sand pit lakes and ponds in the study area support sport fishery species including largemouth bass, black crappie, bluegill, and northern pike.

The most important resident wildlife species are white-tailed deer, ring-necked pheasant, bobwhite quail, wild turkey, cottontail rabbit, and fox squirrel. Common furbearers including mink, muskrat, beaver, raccoon, coyote, red fox, opossum and striped skunk. The above species are most common along the Platte River, its tributaries and the tributaries of the Big Blue River. Various species of amphibians and reptiles are also present.

The study area is within the known range of several federally designated threatened or endangered species. These include the bald eagle, peregrine falcon, whooping crane, interior beast tera, piping plover, American burying beetle, and the Western prairie fringed orchid. The river otter is also found along the middle Platte River and is designated a Nebraska state endangered species.

Migratory birds are very common, especially along the Platte River. Approximately 500,000 Sandhill Cranes and five to seven million ducks and geese, including mallards, pintails, teal, Canada geese, and white-fronted geese, migrate through the central Platte valley annually. The spring migration is a spectacle of national importance. Migratory waterfowl and shorebirds are also numerous at the marshes in the Rainwater Basin.

LEGAL/INSTITUTIONAL FACTORS

INTRODUCTION

The array of legal/institutional factors affecting small community water supplies is so large that even providing a list of relevant laws and regulations can be confusing to the casual reader. Private domestic wells are not as thoroughly affected. This section of this report examines legal/institutional factors in several categories: 1) the regulatory framework (including both well/water system regulation and source water protection related regulation, 2) technical assistance programs and education, and 3) funding sources. Those categories include state, local and federal government responsibilities. Private assistance is also possible in the last two categories. In most instances federal laws and regulations are in practice implemented through parallel state regulations.

In general state level regulation of public water suppliers in Nebraska is provided through the Nebraska Health and Human Services System Department of Regulation and Licensure with some related statutes being administered by the Nebraska Department of Water Resources. Private wells are subject to regulations governing water well construction as of 1988 but are not subject to state or federal water quality testing or water quality standards. State level source water protection regulation is generally provided through the Nebraska Department of Environmental Quality, although pesticide regulation is provided through the Nebraska Department of Agriculture. Authority for local level regulation of nonpoint sources of groundwater contamination is available to the state’s 23 natural resources districts. Most of the above agencies and a variety of other agencies and private entities generally provide technical assistance and education programs relevant to various aspects of public water supplies and source water protection.

In addition to community funding sources the primary government sources of funding for public wells and water systems include: 1) The Community Development Block Grant Program of the U.S. Department of Housing and Urban Development (administered in Nebraska by the Nebraska Department of Economic Development), 2) water and wastewater grants and loans from the U.S. Department of Agriculture Rural Utilities Service, and 3) the State Revolving Loan Fund portion of the federal and state safe drinking water acts (this program should begin providing funding in Nebraska sometime in 1998).

The legal-institutional constraints and structure affecting the detailed study area are similar to those found in the remainder of the state. The major exception to that similarity is probably in terms of the groundwater management areas of the Upper Big Blue NRD and Central Platte NRD. While communities in the detailed study area do have differing amounts of indebtedness and differing incomes those factors also occur in other areas.

REGULATORY FRAMEWORK

Most rules and regulations to administer state laws regarding water wells, water systems, and groundwater protection are codified in legal documents called Titles. Most of those Titles are administered by: the Nebraska Department of Environmental Quality (DEQ), the Department of Regulation and Licensure of the Health and Human Services System (HHSS), the State Fire Marshall's Office (SFM), and the Oil and Gas Conservation Commission (OGCC). Additional legal authority is provided through statutes administered by the Department of Water Resources (DWR), the Nebraska Department of Agriculture (DOA), and statutes enabling action by local units of government.

The following paragraphs do not focus on federal laws or regulation since in practice most of the relevant portions of those laws and regulations are in fact implemented by parallel state regulations.

Well and Water System Regulation

Titles or statutes pertaining to state level regulation of water wells or water systems address the following topics.

1) Public Water Well Permits, Drinking Water Standards, Monitoring, Well Siting, Design, Construction, Operator Certification, Administrative Orders and Exemptions. (The Nebraska Safe Drinking Water Act - Nebraska Revised Statutes 71-5301 to 71-5313, Also Title 179, Chapter 2 HHSS). (The Act also establishes an Advisory Council on Public Water Supply).

2) Water Well Construction, Pump Installation and Water Well Abandonment Standards (Title 178, Chapter 12, HHSS)

3) Licensure of Water Well and Pump Installation Contractors (Including Education Requirements) and Certification of Water Well Drilling, Pump Installation and Water Well Monitoring Supervisors (Title 178, Chapter 10, HHSS)

4) Registration of Water Wells and Notice of Abandonment (Nebraska Revised Statutes 46-602, and Title 456, DWR)

5) Well Spacing (Nebraska Revised Statutes 46-609, 46-651 to 46-654 and Title 456, DWR)

6) Municipal and Rural Domestic Groundwater Transfers Permits (Nebraska Revised Statutes 46-638 to 46-650 and Title 456, DWR)

7) Transfers of Water for Industrial Purposes (Nebraska Revised Statutes 46-675 to 46-690, and Title 456, DWR)

8) Application for Surface Water Rights, (Nebraska Revised Statutes 46-233 through 46-242)

Nitrate Monitoring and Administrative Orders For Communities

The Director of Regulation and Licensure for the Nebraska Health and Human Services System is charged with issuing permits to operate public water systems and setting drinking water and monitoring standards for those systems. That authority is provided by the Nebraska Safe Drinking Water Act (Nebraska Revised Statutes 71-5301 to 71-5313). The Act also allows the director to issue an administrative order specifying corrective action when the Act, a regulation promulgated under the Act, or an exemption has been violated. The director may issue variances or exemptions to the act so long as they are not less stringent than those allowed under the federal Safe Drinking Water Act.

The Health and Human Services System has promulgated regulations governing public water systems (Title 179, Chapter 2) and standards for monitoring nitrate. According to those regulations groundwater entry points for community and nontransient systems are to be monitored annually unless a sample shows nitrate equal to or greater than 5.0 milligrams per liter. Samples must then be quarterly until after four consecutive quarters are below 8.0 milligrams per liter. Water that is above the MCL at the entry point but is treated to meet standards is required to be monitored quarterly.

Private Well Regulation

Private wells are not regulated under the Federal Safe Drinking Water Act but are subject to state well construction regulations. State well construction regulations apply to wells installed since 1988. Recommended standards were available in 1974. Private wells are not subject to state or federal water quality testing requirements or water quality standards. Some commercial mortgage lenders require that private wells be tested as a condition of loan approval and some federal agencies that provide mortgage insurance require testing as a condition of providing their insurance (the Department of Housing and Urban Development and the Department of Veterans Affairs). Inspection of new or existing private wells is not required.

Source Water Protection Related Regulation

A number of laws and regulations can help protect sources of drinking water, including almost the full spectrum of the state's land and water pollution prevention laws. Titles or statutes pertaining to state level protection of groundwater quality or drinking water sources include:

1) Groundwater Quality Standards and Use Classification (Title 118 DEQ)

2) Effluent Guidelines and Standards (Title 121, DEQ)

3) Underground Injection and Mineral Production Wells (Title 122, DEQ)

4) Design, Operation and Maintenance of Wastewater Treatment Works (Title 123), Septic Tanks (Title 124), and Individual Waste Treatment Lagoons (Title 125) (DEQ)

5) Waste Management (Title 126, DEQ)

6) Solid Waste Management (Title 128, DEQ)

7) Livestock Waste Control (Title 130, DEQ)

8) Integrated Solid Waste Management (Title 132, DEQ)

9) Underground Storage Tanks (Title 159, DEQ)

10) Low Level Radioactive Waste Disposal (Title 194, DEQ)

11) Chemigation (Title 195, DEQ)

12) Fertilizer and Pesticide Storage and Handling (Title 198)

13) The Nebraska Pesticide Act - Pesticide Registration and Licensing of Dealers and Applicators (Nebraska Revised Statutes 2-2622 to 2-2655, DOA)

14) Oil and Gas Drilling (Title 267, OGCC)

Laws Enabling Local Regulation

In addition to statutes, rules, and regulations for state level protection of groundwater quality and/or drinking water sources there are statutes enabling local level action to protect groundwater. Those laws allow protective action by communities, counties, and natural resources districts. They include:

1) Local zoning, subdivision, building code and other authorities which can be used to protect public health. These are found in a number of sections throughout the statutes and pertain to various classes of cities and villages. Wellhead protection can be achieved through conservation easement or land purchase and leaseback as well as land use controls. Wellhead protection programs can help protect beyond the 1,000 foot well setback required by Nebraska Health and Human Services System regulations.

2) Extraterritorial jurisdiction beyond corporate limits of cities and villages (1 mile for villages and cities of the 2nd class NRS 17–1001, 2 miles for cities of the 1st class NRS 16–901, 3 miles for primary and metro class cities NRS 15–201.01 and 14–418).

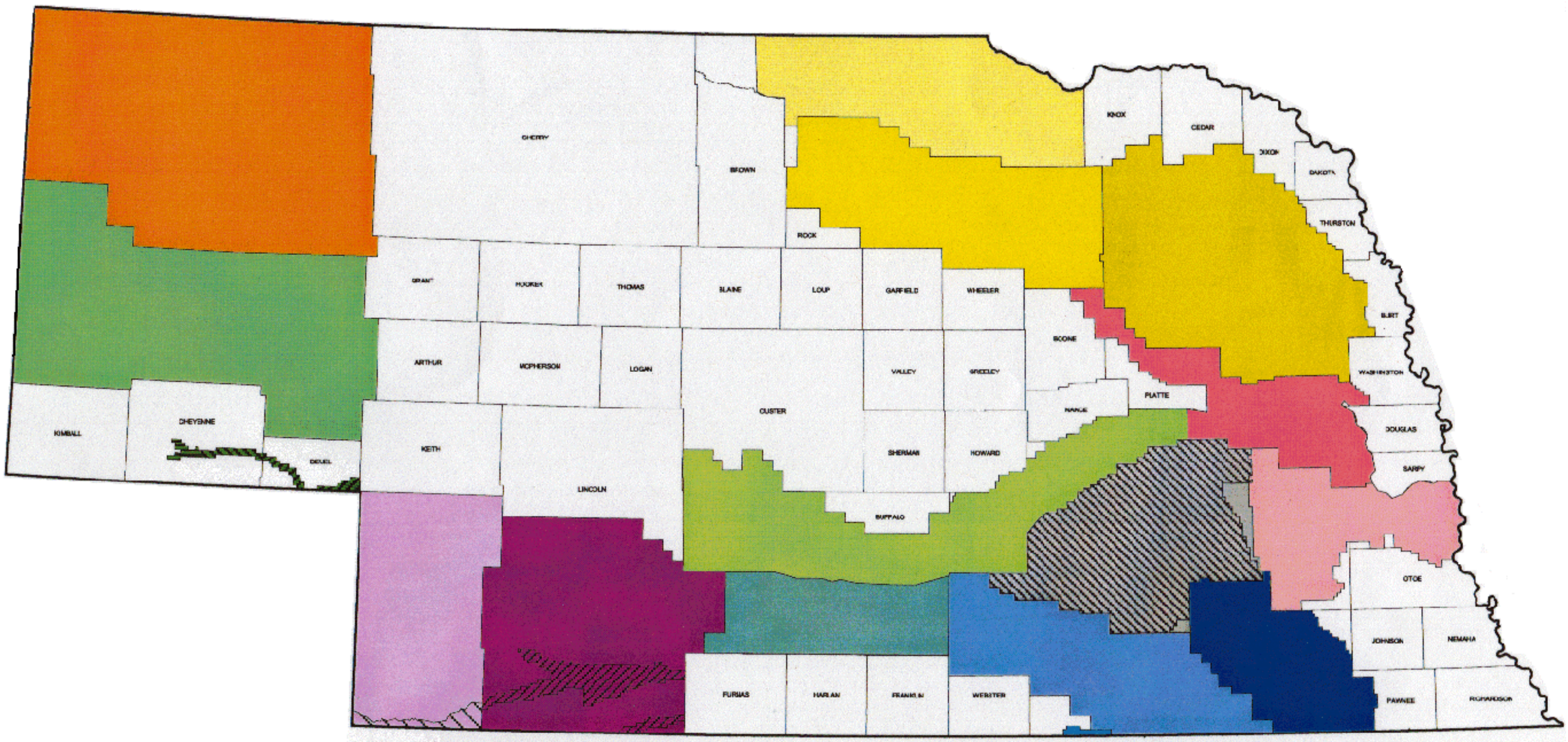
3) Villages and cities of the 2nd class may have a 15 mile jurisdiction to protect the source of their water (untested law from the 1800's) (Nebraska Revised Statutes 17–536).

4) The Groundwater Management and Protection Act (Nebraska Revised Statutes 46–656.01 to 46.656.67) The Act enables natural resources districts to regulate water users in groundwater management areas through: allocation of withdrawal, rotation of use, well spacing, mandatory well metering, reduction of irrigated acres, mandatory chemical analysis of deep soils, or water quality monitoring and reporting requirements. Districts also perform a wide variety of monitoring and educational activities in groundwater management areas. A map showing groundwater management areas as of July 1, 1998 is included as Figure 25. As of July 1998 groundwater management areas covered over 55% of the state's area.

5) The Wellhead Protection Area Act authorizes the controlling entity of any public water supply system to adopt boundaries and controls for a wellhead protection area.

While the intent of these laws is generally to protect human health; citizens of individual communities may not agree that the legal/institutional structure works to that end in each of their cases. Potential discussion points, issues or problems related to the regulatory framework for rural domestic and small community water supplies include the following.

Figure 25 – Ground Water Management Areas



Central Platte (6/1/88)Qq
Deuel County (2/13/95)q
East Lodgepole Valley (9/10/98)q
Little Blue (10/28/96)Qq
Lower Big Blue (2/3/97)q
Lower Elkhorn (1/1/97)q
Lower Niobrara (7/1/96)q
Lower Platte North (1/1/97))q
Lower Platte South (8/13/96)Qq
Middle Republican (7/1/98)q
North Platte (7/10/96)Qq
Red Willow-Hitchcock (SPA 10/17/91)q *
Sidney (12/10/90)q
Superior-Hardy (SPA 2/13/90)q *
Tri-Basin (8/17/89)q
Upper Big Blue (12/9/77)Q
Upper Big Blue (SPA 9/23/93)q *
Upper Elkhorn (6/30/97)q
Upper Niobrara-White (7/1/98)q
Upper Republican (8/1/77)Q
Upper Republican (10/3/97)q

* Water well construction permits required for former Special Protection Areas after July 19, 1996
Q = quantity management area
q = quality management area
Qq = quantity and quality management area

Department of Water Resources
revised 11/23/98 drv

1) *Frequent changes in federal drinking water standards can make it difficult for a community to plan water supply improvements and can result in considerable waste of money as communities attempt to meet changing requirements through piecemeal action.*

2) *Enabling legislation to protect water sources may not be utilized at the local level, and even if it is, it may sometimes be inadequate to prevent contamination of drinking water sources.*

3) *Groundwater protection responsibilities are split between communities, NRDs, and state and federal entities.*

4) *No monitoring is required for private domestic wells nor are such existing wells required to meet water quality standards. This may save needless well owner expense but may sometimes allow contamination to go undetected.*

TECHNICAL ASSISTANCE PROGRAMS AND EDUCATION

Programs at the local, state and federal levels provide technical assistance and education related to water source protection and public water wells and water systems. Addresses and phone numbers for some of these organizations are included as Appendix I to this Section. Those programs include:

1) Nebraska's Source Water Assessment Program (administered by the Nebraska Department of Environmental Quality). Nebraska's Source Water Assessment Program is intended to: (1) identify areas that supply public tap water, (2) inventory contaminants and assess water system susceptibility to contamination, and (3) inform the public of results. It is being developed and administered by the Nebraska Department of Environmental Quality.

2) The Nebraska Wellhead Protection Program (Administered by the Nebraska Department of Environmental Quality)

3) The Nebraska Mandates Management Initiative (Administered by the Nebraska Department of Environmental Quality)

4) UNL Conservation and Survey Division Public Well Location Assistance

5) The mandatory/regulatory education programs of the Nebraska Department of Environmental Quality, and the Nebraska Health and Human Services System

6) Natural Resources District Groundwater Management and Education Programs

7) University of Nebraska Cooperative Extension Programs (The Farm*A*Syst programs are especially helpful in addressing farmstead and acreage homesite water quality problems.)

8) The Natural Resources Conservation Service's Conservation Programs (These provide conservation assistance to agricultural landowners and can have significant water quality impacts to lands near wells.)

9) Private state level educational and assistance efforts through such organizations as the Nebraska Rural Water Association, the Nebraska Well Drillers Association, the Nebraska League of Municipalities, the Midwest Assistance Program, and the Groundwater Guardian Program of the Nebraska based Groundwater Foundation. For instance the Nebraska Well Drillers Association in cooperation with the UNL Conservation and Survey Division has published a brochure entitled "So You Need a Water Well? – A Consumers Guide to Homeowners Drinking Water in Nebraska."

10) The Nebraska Department of Environmental Quality's 319 nonpoint source management program is a comprehensive and dynamic program providing reporting, funding, education and other assistance.

11) Consumer Confidence Report Requirements for Local Water Suppliers. These new requirements will provide added information to water system customers.

12) Some NRDs, NDEQ and NRWA have cooperated in circuit rider programs to assist small communities.

13) The Cooperative Extension Service and NRDs have ongoing programs to address water quality, including testing.

14) The University of Nebraska Water Center is developing a data clearinghouse which is to include nitrate data.

Sources of no and low cost technical assistance and education at the national level include the Environmental Protection Agency, the EPA Safe Drinking Water Hotline, the American Water Works Association, the Rural Community Assistance Program, the Environmental Quality Instructional Resource Center (housed at Ohio State University), and the National Drinking Water Clearinghouse.

The Nebraska Rural Water Association currently provides technical assistance on wellhead protection programs, with a goal of assisting at least 13 communities per year.

The Nebraska Mandates Management Initiative is an especially promising effort where state and local agencies provide extensive technical assistance directly to communities that choose to participate. Of the 69 communities that have had full participation in the program since May 1995, 39 had nitrate concerns related to drinking water supplies listed as an identified issue. In April 1995 the Nebraska Mandates Management Initiative compiled a technical assistance task group report which listed significant water quality related technical assistance programs.

The Nebraska Wellhead Protection Program is intended to prevent groundwater pollution from entering public water supply wells and making them unusable. The Nebraska Wellhead Protection Program has provided significant technical assistance to communities through the delineation of maps showing potential contaminant time of travel for over 200 of those communities. It also provides a manual and assistance for communities wishing to conduct contaminant source inventories and considerable information on wellhead protection.

Wellhead protection can be used as an option when a community is under administrative order for violation of nitrate standards and nitrate levels are below 15 ppm. In such instances bottled water must be provided to infants and pregnant women. A large number of specific wellhead protection activities are detailed in Department of Environmental Quality literature. Communities with wellhead protection programs have a number of options including conservation easements, land purchase and leaseback, land use controls or, in some cases, turning to local natural resources districts (NRDs). NRDs sometimes have provisions in the groundwater management plans to assist with wellhead protection.

The Source Water Assessment Program is a Nebraska Department of Environmental Quality effort that is closely related to wellhead protection. In January 1999 the NDEQ submitted a Source Water Assessment Plan to the U.S. Environmental Protection Agency after which there will be 3½ years to complete the assessment. The Department will be determining the extent possible the origin of contaminants and the susceptibility of public water systems within delineated areas to contaminants for all public water systems.

In addition to licensure/certification/education requirements for water well and pump installation contractors HHSS does offer a technical assistance program and will inspect the condition of a well and look for potential sources of contamination. However, inspection of new or existing private wells is not required.

Potential issues, problems or options associated with existing programs and educational efforts include the following.

1) *In the past communities sometimes adopted treatment or other water supply options without fully consulting all possible sources of assistance. There may be some need to be sure that communities are fully aware of technical assistance options and adequately explore all alternative means of addressing water supply needs.*

2) *There is no statewide program to make sure that areas upgradient of communities wells (20 year time of travel or otherwise) are monitored.*

3) *Communities may not be taking full advantage of the Nebraska Wellhead Protection Program. As of late 1997 only 15 or 16 communities (out of 628 communities statewide) are known to have conducted contaminant source inventories. It will be important for communities to take full advantage of NDEQ's Source Water Assessment Program.*

4) *It may be worthwhile to consider programs to selectively inform private well owners of testing needs and potential risks. A 1994 survey of 5,520 private well owners by the Centers for Disease Control over a nine-state region found that 44 percent of respondents indicated their well had been tested for contamination, 44 percent said their well had never been tested for contamination and 11 percent did not know. Thirty-nine percent who said their well had been tested indicated that the testing took place prior to 1990 (United States General Accounting Office, June 1997, page 20). Although private well owners in Nebraska may be better informed about potential drinking water concerns than consumers in some other states, additional public information efforts may be useful in some situations.*

A June 1997, U.S. General Account Office report *"Drinking Water - Information on the Quality of Water Found at Community Water Systems and Private Wells"* referred to the lack of information by private well owners. It stated "This does not imply that private well users are all at risk or that they should begin to test their water for all of the contaminants regulated by community water systems. That would be unnecessarily expensive. What it does suggest is that when there is information already available from community systems that could alert private well users to possible local contamination problems, these users could benefit from that information. For example, community water systems could provide a copy of their annual water quality report to state and/or local public health agencies, which could then alert private well users to localized contamination problems and advise them to consider having their well tested for specific pollutants, if appropriate. The agencies could publicize the availability of the annual report through the local media, making sure that the notice alerts private well users to the report's potential relevance to their water supply. With the information from the annual report, private well users can make informed choices about testing or maintenance. Without the information, they may not be aware of potentially harmful contamination.

FUNDING SOURCES

There are a variety of sources of funding for public wells and water systems as well as water source protection. Addresses and phone numbers for some of the organizations providing that funding are included as Appendix II to this section. **Some of the sources of funding for public wells and water systems include:**

1) The Drinking Water State Revolving Fund portion of the federal and state safe drinking water acts (The fund program provides loans to eligible public water supply systems for the construction of water works and land acquisition for source water protection. Funds can be used to plan, design and construct drinking water facilities. The fund is administered jointly by NDEQ, HHSS and the Nebraska Investment Finance Authority.

2) Water and wastewater grants and loans from the U.S. Department of Agriculture Rural Utilities Service

3) Community Development Block Grants from the U.S. Department of Housing and Urban Development. In order to receive a grant from this source a community's average water system charges must be at least 1% of median household income. (These grants are administered through the Nebraska Department of Economic Development).

(Note: The Nebraska Mandates Management Initiative has developed a consolidated grant application form that can be used for all three of the above programs).

4) Community Revenue Bonding Authority

5) Community Taxing Authority

6) General Obligation Bond Authority

7) Community User Fee Authority

8) Department of Interior Funds for Indian Reservation Water Systems

9) Federal Emergency Management Agency Funds (for systems damaged by flooding)

10) Bureau of Reclamation assistance in limited circumstances

11) Water 2000 Safe Drinking Water Initiative Funds

Funding for water source protection can come from:

1) Environmental Protection Agency 319 Program Non-Point Source pollution grants

2) Federal Safe Drinking Water Act Funds passed on to State and State Revolving Fund (a state may allocate up to 15% for source water protection)

3) Agricultural land treatment funds (including the Nebraska Soil and Water Conservation Fund, Natural Resources Conservation Service Funds and Natural Resources District cost share)

4) The Nebraska Environmental Trust

5) The Nebraska Environmental Enhancement Fund (scheduled to lapse in December 2000 due to sunset provisions)

6) The Nebraska State Revolving Loan Fund for wastewater (Among other provisions this will allow low interest loans for acquisition of easements on land in a wellhead protection program)

7) The Nebraska Water Well Decommissioning Fund

8) The U.S. Department of Agriculture's Conservation Reserve Program (The Conservation Reserve Program will provide 10% to 20% in extra funds for conservation easements in wellhead protection programs). Land within a 2,000 foot radius of a municipal well has a competitive advantage in the selection process.

Potential issues or problems associated with funding programs for public water wells and systems and water source protection include the following.

1) Although funding programs for water systems have been relatively stable, some communities may still postpone needed action until either a) better grant/loan conditions are available, or b) the community's circumstances meet the need requirements. This can delay needed action.

2) The number of funding programs and their various deadlines can make application processes and coordination difficult. The Nebraska Mandates Management Initiative has a process to address this problem, but it is relatively new and not every community uses it.

3) A cost share program might be useful in helping phase out the large diameter private domestic wells which account for many of the water quality problems of eastern Nebraska domestic wells.

4) Point of use or point of entry treatment systems could be further examined for private wells with nitrate or other water quality problems.

LOCAL GOVERNMENT MANAGEMENT OPTIONS

Local governments can derive income to address water system concerns from a variety of sources. These include:

Income Only	Repayable
Customer Charges	Loans
Property Tax	General Obligation Bonds
Sales Tax	Revenue Bonds
Revenue Sharing	
Grants	

There are a number of options for local governments in the management of water utilities. These include the following:

1) Agreements with outside providers
2) System independence, including the degree to which the water system subsidizes or is subsidized by other city operations
3) Interlocal cooperation agreements including interlocal personnel agreements
4) Wellhead Protection Programs
5) The mix of funding used to finance continuing operations

Local government decisionmaking can be influenced by a number of factors. These include: level of need, local income, other local spending priorities, tax lids, federal and state mandates, and grant and loan availability.

The perception of the need for an upgrade can be a major influence. The cost of an upgrade that isn't immediately needed can be quite high and postponing such expenditures can make a major financial difference to a community. Therefore it is natural for communities to postpone such expenditures so long as community health is not compromised and long-term costs aren't increased. Major capital expenditures on water systems can also have the disadvantage of providing immediate increases in rates and long-term indebtedness while often providing no visible change in the product being delivered. This means evidence of the level of need is very important.

Availability of revenue in terms of local income, other local spending priorities, tax lids, and local tax levels are also factors in local water system decisions. If expenditures on a system would preclude fulfilling other needs or are at the limits or beyond a community's ability to pay; it can place hardship on a community. These factors have helped create demands for grant programs.

Federal and state mandates provide the boundaries of service a system must provide. Minimum training and testing requirements affect ongoing costs and maximum contaminant levels provide a minimum standard of water quality. However, the changing nature of federal and state mandates can add to a community's quandary in upgrading water system components. This can be especially true for newly established maximum contaminant levels. A community can make an investment in one type of treatment or other system option only to find the rules have changed and that it would have been better to choose a different treatment option that would have addressed the new standards. A community may also wish to delay action until it knows what new standards are likely to be. The lead and copper rule may have resulted in this type of dilemma in some instances.

Another major factor in local government decisionmaking is the availability of grants and loans. Because this can have a major effect on community costs it may also affect the timing of system improvements. Because grant and loan programs and their funding levels can change through time, this may sometimes affect the timing of community decisions.

A major potential weapon in a community’s pollution prevention arsenal is the wellhead protection program. Through use of contaminant source inventories, land purchase and leaseback, conservation easements or land use control communities can help prevent future threats to their water sources.

LEGAL-INSTITUTIONAL FACTORS SPECIFIC TO THE DETAILED STUDY AREA

The Upper Big Blue NRD each has a groundwater management area which addresses both water quantity and quality concerns and the Central Platte NRD has a groundwater management area addressing water quality. According to Nebraska Department of Water Resources information, the provisions of those groundwater management areas as of February 1997 were as follows.

Central Platte (quality)

1.	0 - 12.5 ppm NO_3 -	1.	<u>fall and winter applications of commercial nitrogen fertilizer regulated or banned on some soils; mandatory attendance of district educational program</u>
2.	12.6 - 20.0 ppm NO_3 -	2.	<u>continue phase 1 controls; continuous monitoring of inches applied per acre; annual lab analysis for nitrate in water from each irrigation well; deep soil analysis for nitrate; annual reporting on management history and plans</u>
3.	>20.0 ppm NO_3 -	3.	<u>continue phase 2 controls; further restrictions on commercial nitrogen fertilizer and further monitoring regulations</u>

Upper Big Blue GWMA#1 (Quantity)

1.	land area designated in 1977 originally as a control area (most of NRD)	1.	<u>well spacing restrictions; restrictions on ground water transfers; certification of ground water use acres and water wells</u>
2.	declines below 2 ft. above 1978 level	2.	annual ground water use reports
3.	declines below 1978 level	3.	flow meters required; allocations

Upper Big Blue GWMA#2 (Quality)

1.	whole district designated 9/23/93 originally as a special protection area	1.	<u>anhydrous ammonia prohibited before November 1; preplant nitrogen prohibited before March 1; reporting necessary if nitrates reach 9 ppm</u>

2.	9 ppm median nitrate and <60% acreage farmed w/BMPs or 12 ppm median nitrate and <75% acreage farmed w/BMPs	2.	continue phase 1 controls; educational certification; deep soil sampling; irrigation scheduling; reporting of BMPs
3.	12 ppm median nitrate and <75% acreage farmed w/BMPs or 16 ppm median nitrate and <90% acreage farmed w/BMPs	3.	continue phase 2 controls; deep soil sampling; irrigation reporting; irrigation water sampling once per three years; operator must calculate nitrogen application rate for each field taking into account all nitrogen credits

This report does not cover legal-institutional factors specific to the detailed study area other than NRD groundwater management areas. For the most part the relevant legal-institutional factors do not differ markedly from those for the state in general.

References

Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Population Projections, 1990 to 2010, April 1997

Bureau of Business Research, University of Nebraska-Lincoln, Nebraska County Profiles, BBR Internet Website

Centers for Disease Control and Prevention, U.S. Public Health Service, "A Survey on the Quality of Water Drawn from Domestic Wells in Nine Midwestern States", November 1996

Conservation and Survey Division – University of Nebraska-Lincoln and Nebraska Department of Health, Domestic Well Water Quality in Rural Nebraska – Data Analysis Report, April 1996. Data Analysis Report Leaders David C. Gosselin, Jacqueline Hedrick, Xun-Hong Chen, Scott Summerside, Rod Tremblay and Kurt Bottgen, p. 9

Exner, Mary E. and Spalding, Roy F., Occurrence of Pesticides and Nitrate in Nebraska's Groundwater, University of Nebraska-Lincoln, Water Center, 1990, p. 3

Goans, Steve, Conservation with Steve Goans, Nebraska Department of Environmental Quality, April 1998

Kaul, R.B and Rolfsmeier, S.B. Native Vegetation of Nebraska

Keefer, Gary B. and Lamberty, Louis, Drinking Water and Wastewater Treatment Facilities in Nebraska Community Under 10,000 Population, University of Nebraska-Lincoln, Center for Infrastructure Research, August 1995

Nebraska Agricultural Statistics Service, Nebraska Agricultural Statistics, various years, Nebraska Department of Agriculture

Nebraska Department of Economic Development, Community Development Block Grant Files

Nebraska Department of Environmental Quality, Nebraska Mandates Management Initiative – Local Governments Assisted and Process Status – January 1998

Nebraska Health and Human Services System, Files on Community Water System Monitoring, Administrative Orders, and Community Water System Improvements

Nebraska Health and Human Services System, Nebraska's Public Water Supply Program – Summary Report – 1997

Nebraska Health and Human Services System, Nebraska's Public Water Supply Program Summary Report – 1996

Nebraska Natural Resources Commission, 1982, Policy Issue Study on Groundwater Reservoir Management, unpublished draft material

Nebraska Natural Resources Commission, Estimated Water Use in Nebraska – 1990, December 1994

Nebraska Natural Resources Commission, Estimated Water Use in Nebraska – 1995, April 1998

Nebraska Natural Resources Commission, Files on Rural Water Supplies, 1998

Nebraska Rural Water Association, 1997 Rate Survey

Nebraska Soil and Water Conservation Commission, May 1971, “Report on the Framework Study for Nebraska’s State Water Plan, Publication #101

Steele, Eugene K., Estimated Use of Water In Nebraska, 1985, Nebraska Water Survey Paper #64, U.S. Geological Survey, Published in cooperation with Conservation and Survey Division, University of Nebraska, June 1988.

Supalla, Ray and Saeed Ahmad, “Defining the Financial Capability of Rural Communities to Meet Server and Water Needs,” July 1997

U.S. Department of Agriculture, Soil Conservation Service, Nebraska Natural Resources Inventory Tables, Lincoln, Nebraska, May 1994

U.S. Department of Commerce, Bureau of the Census, Census of Population, various years

U.S. Department of Commerce, Bureau of the Census, U.S. Census of Agriculture, various years

U.S. Environmental Protection Agency, Drinking Water Infrastructure Needs Survey, First Report to Congress, January 1997

U.S. General Accounting Office, Drinking Water Information on the Quality of Water Found at Community Water Systems and Private Wells, June 1997, p. 20

Related Material

Frensel, S.A., R.B. Swanson, Til Huntzinger, J.K. Stamer, P.J. Emmons and R.B. Zelt, Water Quality in the Central Basins, Nebraska, 1992-95, U.S. Geological Survey Circular 1163

Hammer, Mark J., Status of Public Water Supplies in Nebraska, September 1980

Huntzinger, Thomas L., “Nitrate Content in Water is Related to Agricultural Land Management” in “Water Quality in the Central Nebraska Basins, Nebraska 1992-1995”, U.S. Dept. of the Interior, U.S. Geological Survey, Circular 1163 by S.A. Fenzel, et al, 1998

Attachment 1

SELECTED SOURCES OF TECHNICAL ASSISTANCE AND EDUCATION RELEVANT TO COMMUNITY WATER SUPPLIERS AND SOURCE WATER PROTECTION

NEBRASKA

Nebraska Health & Human Service System
Dept. of Regulation and Licensure
P.O. Box 95007
Lincoln, NE 68509-5007
(402) 471-3132

Information and technical assistance on public water systems including inspection/findings, evaluation of proposed well locations, providing technical guidance to engineers, education and certification programs for operators, on-site technical assistance and infrastructure needs assessment.

Nebraska Dept. of Environmental Quality
P.O. Box 98922
Lincoln, NE 68509-8922
(402) 471-2186

Administers the Nebraska wellhead protection program and the Nebraska Mandates Management Initiative, each of which provides extensive assistance to small communities. Also provides education and technical assistance on wastewater facilities and septic tanks and field assistance on contamination problems.

University of Nebraska-Lincoln Conservation & Survey Division
113 Nebraska Hall
University of Nebraska-Lincoln
Lincoln, NE 68588-0517
(402) 472-3471

(Evaluates proposed location of water wells, repository of geologic information.)

Nebraska Rural Water Association

P.O. Box 186
Wahoo, NE 68066
(402) 443-5216
(402) 443-5274 FAX

(Gathers and provides information on water system rates, provides on-site technical assistance, assists infrastructure assessment, promotes model ordinances and provides personnel to assist with wellhead protection programs.)

Midwest Assistance Program (Rural Community Assistance Program)
P.O. Box 4D
Walthill, NE 68067
(402) 846-5123
(402) 846-5152 FAX

(Helps communities assess infrastructure needs and evaluate water rates — provides assistance to communities on writing Community Development Block Grant and Final Economic Development Administration Grant Fund applications.)

American Water Works Association
Nebraska Chapter

Nebraska League of Municipalities
1335 L Street
Lincoln, NE 68508
(402) 476-2829

(Promotes model water ordinances and assists with water operator training and on-site technical assistance.)

The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542
(402) 434-2740
(402) 434-2742 FAX

(Operates the National Groundwater Guardian Program, an education and recognition program to help communities to protect their groundwater resources. Groundwater Guardian relies on voluntary steps developed at the community level.)

Nebraska Association of Resources Districts

601 S. 12th, Suite 201
Lincoln, NE 68508
(402) 474-3383
(402) 474-0919   FAX

University of Nebraska-Lincoln - Cooperative Extension Program
211 Agricultural Hall
University of Nebraska-Lincoln
Lincoln, NE 68583

(Education, information and demonstrations on a wide variety of agricultural and water related topics.)

University of Nebraska-Lincoln - Water Center
103 Natural Resources Hall
University of Nebraska-Lincoln
Lincoln, NE 68583-0844
(402) 472-3305

(Contact for University of Nebraska Water Research)

Nebraska Rural Development Commission
301 Centennial Mall South
P.O. Box 94666
Lincoln, NE 68509-4666
(402) 471-6002

(Fosters sustainability and economic development initiatives in rural areas.)

<u>NATIONAL</u>

Environmental Protection Agency Region VII
726 Minnesota Avenue
Kansas City, KS 66101

(Information on water quality standards, system management, and operations.)

The EPA Safe Drinking Water Hotline

1-800-426-4791

(Current information regarding EPA's drinking water regulations and policies — also mails EPA drinking water publications.)

The American Water Works Association
6666 W. Quincy Avenue
Denver, CO 80235
(303) 794-7711

(A scientific and educational organization that sponsors conferences/workshops on drinking water topics and develops publications on waterworks. Their small systems program provides information, technical assistance and training to small systems.)

The Rural Community Assistance Program
602 South King Street, Suite 402
Leesburg, VA 22075
(703) 771-8636

(Regional affiliates provide training and technical assistance on water, wastewater and solid waste projects. Offers publications on water system planning and operations and management.)

The National Drinking Water Clearinghouse
P.O. Box 6064
Morgantown, WV 26506-6064
1-800-624-8301

(Offers financial and technical information for communities of 10,000 people and under. Also researches and answers questions, maintains a computer database, and offers technical products.)

The Environmental Quality Instructional Resources Center
Ohio State University
1200 Chambers Road, Room 310
Columbus, OH 43212-1792
(614) 292-6717

(Provides information on system design, operation and management including training manuals and audio-visual materials.)

Natural Resources Conservation Service - U.S. Dept. of Agriculture
State Conservationist's Office
152 Denney Federal Building
100 Centennial Mall North
Lincoln, NE 68508-3866
(402) 437-5300

(Provides technical assistance to farmers, ranchers and other landowners to conserve and protect natural resources.)

Attachment 2

SELECTED SOURCES OF FUNDING RELEVANT TO COMMUNITY WATER SUPPLIES AND SOURCE WATER PROTECTION

WATER SYSTEMS

Nebraska Health and Human Services System
Department of Regulations and Licensure
P.O. Box 95007
Lincoln, NE 68509-5007
(402) 471-2133

(Administers the State revolving loan fund portion of the Safe Drinking Water Act.)

Rural Utilities Service - U.S. Department of Agriculture
308 Denney Federal Building
100 Centennial Mall North
Lincoln, NE 68508
(402) 437-5551

(Administers loans and grants to develop water and waste disposal systems in rural areas and towns.)

Nebraska Department of Economic Development
P.O. Box 94666
Lincoln, NE 68509-4666
(402) 471-3111

(Administers Community Development Block grants which are used for water system infrastructure in some small communities.)

Source Water Protection

Nebraska Health & Human Services System
Department of Regulation and Licensure
P.O. Box 95007
Lincoln, NE 68509-5007
(402) 471-2133

(Has the option to allocate a portion of the State Drinking Water Revolving Fund to source water protection.)

Nebraska Department of Environmental Quality
P.O. Box 98922
Lincoln, NE 68509-8922
(402) 471-2186

(Administers 319 nonpoint source pollution grants as well as other water quality related funds.)

Nebraska Environmental Trust
2200 N. 33rd Street
P.O. Box 30370
Lincoln, NE 68509-0370

(Trust fund can be used "for the purpose of conserving, enhancing, and restoring the natural, physical and biological environment of the state.")

Nebraska Natural Resources Commission
P.O. Box 94876
Lincoln, NE 68509-4876

(Allocates a Soil and Water Conservation Fund for agricultural measures. That fund is administered through local natural resources districts. NRC also administers the Natural Resources Enhancement Fund which can be used for water quality incentives and is also administered at the local level through natural resources districts as is the Commission's Water Well Decommissioning Fund. Also administers the Nebraska Resources Development Fund for Water Projects.)

Natural Resources Conservation Service - U.S. Dept. of Agriculture

State Conservationist's Office
152 Denney Federal Building
100 Centennial Mall North
Lincoln, NE 68508-3866
(402) 437-5300

(Administers Environmental Quality Incentives Program.)

Farm Service Agency - U.S. Dept. of Agriculture
7131 A Street
P.O. Box 57975
Lincoln, NE 68505-7975
(402) 437-5581

(Administers a Water Quality Incentives Program for farmers. Also administers the Conservation Reserve Program that provides cost share for lands taken out of crop production including extra cost share for lands in wellhead protection areas.)

Nebraska Association of Resources Districts
601 South 12th Street, Suite 201
Lincoln, NE 68508
(402) 474-3383
(402) 474-0919 FAX

(The Nebraska Association of Resources Districts is a contact for Nebraska's 23 local natural resources districts. Those districts supply local matching conservation funds and sometimes help administer other funds or grants dealing with source water protection.)

Attachment 3

SAMPLE OF SURVEY LETTERS SENT TO COMMUNITIES WHICH MAY HAVE MADE NITRATE RELATED INFRASTRUCTURE EXPENDITURES

June 30, 1998

To: Selected Community Water System Contacts:

Our agency is developing a rough summary of community expenditures on water system improvement projects since 1981 that were at least partially related to nitrate in community water supplies. We are unsure of the validity of some of our data. Our information indicates that in _________ the City/Village of __________ submitted project plans to make water system improvements which ultimately had or will have an approximate total cost (including grant or loan money) of ___________. Our available data does not indicate with certainty whether or not nitrate levels in the community's wells prior to that time were one of the major reasons for the project.

We would appreciate having you fill in and return the enclosed form to let us know whether nitrate was a major factor. If you can easily access the data, we would also appreciate your confirmation on whether the expenditure figure we have provided is approximately correct. A stamped self addressed envelope is enclosed. If possible, we would appreciate your response within the next two weeks. If you have any questions, please feel free to call me at (402) 471-3955. Thank you for any assistance you are able to provide.

Sincerely,

Steve Gaul
Head, Comprehensive Planning Section

Enclosure

June 30, 1998

Return to:

Nebraska Natural Resources Commission
P.O. Box 94876
Lincoln, Nebraska 68509-4876

Name of Community ____________________________

(Yes/No) **_________ Was nitrate one of the major reasons your community initiated the water supply improvement project mentioned?**

(Yes/No) **___________ Is ______________ the approximate total cost of the project?**

If the above amount is incorrect, we would appreciate receiving a correct expenditure figure for the project, if possible.

Actual Total Cost ________________.

Other Information:

Note: Thank you for any information you are able to provide.